# MICRO-LEVEL PLANNING AND DEVELOPMENT PROCESSES



Volume II

Methods and Techniques of Integrated
Rural Area Planning

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## INTRODUCTION

This report constitutes Volume II of a larger study on Micro-level planning conducted by the Institute of Development Studies for the Ministry of Agriculture, Government of India. Volume I reviews the local and intermediate level planning processes and programmes in India. The present volume deals with the methods and techniques of micro-level planning and the final volume presents a case study of micro-level planning in Chitradurga district of Karnataka State within the framework of drought prone area programme.

India has been engaged in micro-level planning at the district or lower levels for quite some time. In recent years, greater emphasis has come to be laid on grass-root approach to planning and a number of area development programmes (reviewed in part one) were launched to meet this end. Most of these, however, had only a marginal success. There appears to be three basic reasons for the poor performance of these programmes:

1) they were poorly formulated;
2) they were too loosely integrated with other programmes; and
3) they were haphazardly implemented.

An attempt has been made in this volume to explain the methods and techniques of plan formulation including their integration with other programmes and projects. The report consists of eighteen chapters, one leading to the other. Starting with the concepts pertaining to area development, it covers problems and methods of selecting areas for development, methods of integrating area development plans sectorally and spatially, models of development,

general analytical methods useful in planning, land use planning, watershed planning, evolving efficient rural structure and network planning for rural areas. The last four chapters deal with the methods of project formulation and evaluation.

The objective of this report is to provide a ready reference to administrator planners on how to prepare an integrated rural area development plan. The emphasis is, however, on methods, for, the lack of knowledge of these appears to be the weakest link in the plan formulation process at present. Special care has been taken to present even the mathematical methods in the simplest language possible. It is hoped that the volume would be of some use to area development planners.

A number of chapters of this volume have been reproduced from various sources and some of them have been contributed by other scholars closely associated with the training programme of the Institute of Development Studies. Credit has been given to authors of reproduced or edited materials at appropriate places.

I am very thankful to Mr. D. Aurora, Director, Drought Prone Area Programme, Ministry of Agriculture, New Delhi, for having given us the opportunity to participate in the research programme he has launched under the auspices of his unit.

August 15, 1976 R.P. MISRA

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Chapter I

## INTRODUCTION TO RURAL DEVELOPMENT*

This report essentially deals with integrated planning of rural areas. In other words, it deals with a very well-known, but perhaps not so well understood, question of rural development. Before we discuss the various methods and techniques of integrated rural area development, it would be worth while to make ourselves clear about what rural development means.

In the first place, it should be made clear that rural development is not the same as agricultural development, although the latter is obviously an essential part of it. Indeed, experience has shown that an exclusive concern with agricultural development from the point of view of growth and increased output can run counter to the basic objectives of rural development as defined below: there are examples to show that when absolute priority is given to the improvement of large-scale farming, and more particularly to the production of export crops, there may be a deterioration of the conditions of the rural masses and certainly a further skewing of income distribution in favour of the well-to-do. In short, it is by no means certain that a rapid development of the most progressive sectors of agriculture will in fact subsequently benefit the rural sector as a whole; we shall revert to this point later.

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* This chapter constitutes the edited version of a paper on Rural Development: Problems and Strategies by Desmond L.W. Anker, published by the International Labour Organization, Geneva.

Nor is rural development primarily a matter of welfare. There is a tendency, particularly in the British usage of the term, to consider rural development as relating primarily to such activities as community development and the improvement of health and amenities in rural areas. While these must be important elements in the process, rural development is much more than that.

The essence of the concept is of course a geographical one - it is concerned with the problems of rural areas as distinguished from those of urban conglomerations. But it is also an operational concept rather than a theoretical one. A working definition therefore might be somewhat as follows: "Strategies, policies and programmes for the development of rural areas and the promotion of activities carried out in such areas (agriculture, forestry, fishing, rural crafts and industries, the building of the social and economic infrastructure) with the ultimate aim of achieving a fuller utilisation of available physical and human resources and thus higher incomes and better living conditions for the rural population as a whole, particularly the rural poor, and effective participation of the latter in the development process".

Such a definition, however, should not be construed as implying that strategies and programmes for the rural sector should be developed in isolation. On the contrary, in order to have maximum effect they must be coordinated with those relating to urban and industrial development, as will be shown later. Before the rural sector can make its proper contribution, however, it often needs priority in resource allocation.

The fact that rural development is basically a geographical concept would not in itself necessarily justify separate treatment. What is it that sets the rural sector apart? The overriding factor is the nature of farming and its close dependence on nature. Agriculture particularly is governed by nature, and so also are many other economic activities in the rural sector; the level of production can vary up or down, largely independently of human control. The farmer is therefore in an entirely different position from that of the manufacturer, who can adjust his output to variations in demand and other factors. One can of course argue that there are other non-rural activities which also depend largely on the weather - ice-cream vendors on the one hand and roast chestnut sellers on the other, or winter or summer tourist industries - but these play a much less significant role in agriculture than in the economy as a whole.

There are other factors that set rural activities apart. More than other production activities, farming is governed by the law of diminishing returns, i.e., increased doses of fertiliser, for example, do not result in proportionate increase in yield, and after so many doses, yields stop increasing altogether; the demand for agricultural produce is limited by the demand inelasticities for food; as an individual producer the farmer has little control over prices - he typically sells at cost or at the best wholesale prices but pays retail prices for farming requisites as consumption goods; institutional forces, such as land tenure, are much more important than in the other sectors. In less developed countries many farmers and craftsmen are still engaged primarily in subsistence production, which means that production incentives operate

effectively only up to the point where immediate wants can be satisfied. Finally, and perhaps most important, rural activities, even in more advanced peasant societies, are a way of life as well as an occupation.

## A. Problems of the rural sector

Within the confines of a short article I shall not attempt to analyse in any detail the variety of problems that face the rural sector in developing countries. The following are among the more significant.

### 1. Low productivity:

Low productivity is a typical problem in farming and other rural occupations in the developing world. Many farmers and craftsmen are operating at a level of technology that has not changed in centuries. As far as farming is concerned, although in most developing countries one finds examples of highly productive land farmed efficiently with good yields, most of the cultivators - certainly most of those who are still in a subsistence economy - farm on impoverished soils, which are subject to extreme uncertainties of climate, use primitive methods and equipment and have limited access to credit in order to obtain better inputs. All this leads to extremely low levels of output and therefore of income. Similarly the skills of rural craftsmen are essentially those handed down from father to son: they use poor materials and rudimentary equipment and their products are frequently of poor quality. Incomes from farming and other rural activities are therefore barely sufficient - if at all-to cover minimum subsistence needs. Many of the rural poor are permanently in debt, and an unforeseen event such as a crop failure leaves them

destitute. The market for the products of domestic industries is severely limited by the lack of purchasing power in the rural sector, where most of the population lives.

2. Underutilisation of human resources:

The concept of underutilisation of human resources covers a broad spectrum of problems and may be considered from different points of view. In the first place, there may be virtual unemployment in agriculture during the lean season or during times when climatic conditions make farm work impossible. Secondly, where the farms are small and use primitive methods, as in many of the less developed countries, the labour of the cultivator and of his family is not fully utilised except during certain peak periods of the year, and there are few possibilities of other employment. Thirdly, and in contrast to this, many farmers or rural craftsmen work very hard and long hours, but because of the poor resource base and the primitive technology employed their output is extremely low and there is therefore little material return for their labour. Various attempts have been made in recent years to estimate the amount of labour that can be withdrawn from agriculture without negatively affecting outputs. Such estimates, which range from less than 10 per cent up to 40 per cent, should be taken as representing no more than very rough illustrations of the possible dimensions of the problem. Nor should it be forgotten that during the short peak seasons, and particularly at harvest time, all available labour is required and extra hands even have to be brought in.

3. Defects in the agrarian structure:

Various defects in the agrarian structure can be identified. Above all, there are systems of land tenure

which either do not encourage progress or which act as a definite brake on progress. They include, in particular, the concentration of land ownership in the hands of a few, with the consequential monopoly of economic, social and political power. These situations are frequently accompanied by systems of tenancy and of labour which border on serfdom and by a number of economic and social factors, such as the caste system in some countries, which act as a strait-jacket on social mobility. In these circumstances there is no social mobility. In these circumstances there is no possibility, such as existed in the countries that are now industrialised, of climbing up the agricultural ladder, i.e. of starting out as a farm labourer and progressively advancing to the status of tenant and ultimately to that of farm owner. Other defects in the agrarian structure include fragmentation of holdings, frequently due to the rigidity of the laws of inheritance; customary tenures to the extent that they interfere with agricultural modernisation programmes; and the lack of an adequate institutional structure to cater for the needs of farming. This last point will be further discussed below:

4. Poor living and working conditions:

Rural areas in developing countries typically lack good housing, social services and amenities. Wages in agriculture and small rural enterprises are lower than those in urban and industrial occupations. There is furthermore a considerable dearth of public services, especially roads, water supply, electricity and sewerage. Much of this can be ascribed to the neglect of rural areas on the part of government departments, whether it be with respect to health and education or even to economic and technical services, especially for the rural poor. Agricultural extension services cater mostly for the bigger

farms. Extension services for rural crafts and industries are virtually non-existent.

5. Inappropriate education:

This brings me naturally to the wider problem of education and training, about which I shall have more to say below. Until recently schools in rural areas in many developing countries were few and far between. Therefore rate of illiteracy among the old is very high. With the rapid expansion of education, the situation is changing rapidly. While attempts are being made to eradicate illiteracy, the problem of finding meaningful employment for the school leavers remainsto be tackled. They are not qualified for the jobs that are available because they have been taught the wrong things or because the jobs to which they aspire do not exist. It is largely a problem of matching employment opportunities and expectations.[1]

6. Inadequate institutional base:

Rural people, particularly those who are underprivileged, seldom have any organization that can defend their interests and represent them in planning and policy making bodies, or make it possible for them to participate in the development effort. Even co-operatives, whose original purpose was to improve the lost of the underprivileged, do not appear always to cater for the rural poor. In general there are few institutional credit or marketing facilities available for the small farmer and artisan. This must surely be regarded as one of the main reasons why

1. See Louis Emmerij: "Research priorities of the World Employment Programme", in International Labour Review, May 1972, p. 415.

most of the rural population remain on the fringes of development instead of being fully integrated in the development process.

It is therefore little wonder that so many of the rural poor, living in utter poverty and despair, decide to try their luck in the city and drift there in increasing numbers, vainly hoping to obtain jobs that will enable them to make a decent living. This applies particularly to the young whose education has given them aspirations which they feel they cannot achieve in a rural environment as it is now. But since industrialisation in developing countries has not produced the number of jobs required,[2] too many of the migrants end up living in squalor in urban shanty towns. What is happening is that poverty, with its host of accompanying social problems, is being transferred from the rural to the urban areas.

7. Population growth:

The problems briefly mentioned above are all becoming more acute with the rapid growth of population, especially in rural areas. In the past, with high rates of infant mortality, country people liked to have many children, so as to be sure that some of them would survive to help on the farm or to add to family earning in some other way, as well as to take care of their parents in their old age. With improved preventive medicine, death rates among the young (and the old for that matter) have dropped, so that more children survive.

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2. For a recent treatment of the problems of urban employment see Paul Balroch: Urban unemployment in developing countries. The nature of the problem and proposals for its solution (Geneva, ILO, 1973).

The rapid growth in population is reflected in various ways: less land per head and shrinking farm sizes; fierce competition for land, forcing up land prices and rents as future purchasers or tenants outbid each other; increasing landlessness; and equally fierce competition for jobs. It is hardly necessary to mention that population growth means more mouths to feed, so that in spite of improved farming techniques the food supply can barely with the demand. Recent studies have shown that there is reason to believe that malnutrition of young children may result in brain damage, which is likely to affect their ability as producers in adult life. Rapid population increases also exert further pressure on already inadequate social services and facilities of all kinds - schools and health and technical services - so that the quality or quantity of such services is diminished: for example, in some countries that have succeeded in reducing the proportion of illiterates, their absolute number is increasing.

Undoubtedly a tremendous effort is required to obtain acceptance of some form of family planning by rural people.

## B. Approaches and strategies

In most of the developing countries the economy is a dual one: on the one hand there is a modern sector and on the other there is a traditional or "informal" one.[3]

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3. On the concept of the informal sector see ILO: *Employment, incomes and equality. A strategy for increasing productive employment in Kenya*, Report of an inter-agency team financed by the United Nations Development Programme and organised by the International Labour Office (Geneva, 1972); pp.5-6.

The latter is characterised by ease of entry, reliance on indigenous resources, family ownership of enterprises, small-scale operation, labour-intensive and adapted technology, skills acquired outside the formal school system, and unregulated and competitive markets. In the rural sector this division is apparent from the existence of plantations and other large-scale commercial farms and a few modern rural industries on the one hand and a mass of small farmers, landless workers and craftsmen on the other. The gap in income and social conditions between the two is already wide, and becoming wider.

In view of the above mentioned duality of the economy, policy makers have a number of difficult choices to make.[4] Should they concentrate limited national resources and government assistance on the modern sector, which means in fact the formal urban sector and the plantations and large and progressive farms, in the expectation of promoting a rapid growth of output and of the gross national product, and also higher export earnings? Such a policy is likely to widen the gap between the rich and the poor and leave the mass of the rural population untouched. There is a grave risk, for example, that technological changes in agriculture, particularly the processes that have become known as the Green Revolution, will mainly benefit the better-off farmers, and that the conditions of the masses will become worse. The premise that the

4. For an excellent review of the recent thinking on many of the topics touched on the following pages see Guy Hunter: "The Food Research Institute's 50th Anniversary Conference, Strategies for Agricultural Development in the 1970s: a summary and critique", in Food Research Institute Studies in Agricultural Economics, Trade and Development (Stanford University), Vol.411 No.1, 1973.

benefits of improvement in the most favoured sectors of the economy will ultimately trickle down to the rest is not borne out in practice. The situation in such countries as Mexico, Iran and Pakistan appears to confirm this: very rapid strides have been made in some sectors, including agriculture in irrigated areas, but this has hardly benefitted the bulk of the rural poor, who continue to suffer from unemployment, underemployment and low income.

Alternatively, should the policy be, without putting a brake on progressive sectors of the economy, to concentrate on improving the lot of the rural masses who are still largely in the subsistence economy? This could ensure fuller utilisation of labour, which is the major resource of developing countries, and a better distribution of income; and the resulting higher purchasing power of the rural masses would create a wider market for consumer goods as a basis for the development of domestic industry. This policy is a more difficult one to follow than that described in the previous paragraph, and it may well take longer to produce spectacular results, because of the very numbers involved and because it requires major institutional changes, which are long-term processes. It would seem, however, to be the only satisfactory solution, particularly if one bears in mind the cost of inaction so aptly described in a recent report.[5]

There is a further choice to be made with respect to rural development, and this is whether a sectoral or an integrated approach is to be adopted. There is much to be said in favour of a multi-pronged attack if for no other reason than that action in one field is likely to

5. ILO: Employment, incomes and equality, op.cit., pp. 325-329.

call for things to be done elsewhere; an increase in production requires marketing, which depends on roads, which calls for training of necessary workers, and so on. This does not, however, mean that nothing should start until all activities are ready to be launched. With respect to farming more and more countries are adopting a "package" approach providing all the necessary inputs, both material and in the form of assistance, in order to improve production. Such programmes should preferably be combined with other schemes for the generation of employment and income, such as those for the promotion of rural crafts and industries and rural works schemes for the unemployed and grossly underemployed. The necessary adjustments would need to be made in tenure arrangements so that agricultural improvement schemes indeed become possible, and a wide range of social services and amenities provided to make rural life more attractive. These various activities will certainly call for a considerable effort in training in various fields and at various levels, including the staff who are to be responsible for the implementation of the development schemes. Finally, all this needs to be accompanied by the promotion of suitable types of organisations of rural people, allowing popular participation in both the planning and the execution of the development effort. Appropriate action will have to be taken at the local level and a considerable degree of co-ordination among the government agencies concerned will be necessary.

In addition to being planned within the framework of national development policy, such efforts can with advantage be part of a regional development plan. The region, which should as far as possible have a certain geographical and economic unity, should preferably also contain an urban centre so that the various development

schemes foster the closest possible links between the rural and urban economies and particularly a complementarity of benefits between the two sectors. There are likely to be advantages in creating a number of poles of growth or focal points around which the development effort can be built, so that there may be balanced growth of the centre and of its hinterland. Consideration can be given to a three-tiered structure, with villages, larger rural centres and the regional town which is the headquarters of the regional development effort.

Above all - and this applied to virtually all of the topics examined in this article - more needs to be known about how the rural sector functions, what are the constraints and bottle-necks impeding development, what incentives are likely to be of most use and what have been the results of development efforts so far. There is therefore a tremendous need for more and better data. Without this, to paraphrase Turnham,[6] there will continue to be a huge gap between what we believe the problems to be and what we actually know about them, so that much time and money is wasted on preparing plans and implementing programmes without a clear idea of what is involved.

1. Technology:

Technology in rural occupations needs improvement. But this does not mean that the most modern techniques are called for or that those which have been developed in the highly industrialised countries are necessarily

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6. David Turnham: The employment problem in less developed countries, a review of evidence, OECD Development Centre Studies, Employment Series, No.1 (Paris 1971), p. 120.

suitable in developing countries. What is required is the introduction of technology that is appropriate to the particular conditions of the country concerned.[7] An example is the various types of farm implements that have been develop in Japan to suit the generally small size of holdings as well as the farming systems and soils and topography in tha country. Inappropriate farm mechanisation is a good exampl of the errors that may be committed in introducing foreign technologies. Much has been written about the wastage of resources associated with large-scale mechanised agricultural schemes in Africa - wastage not only because the equipment was not suitable and soon were out, but also because tractor cultivation did severe damage to the soil. Those who travel in rural areas in developing countries are horrified at the amount of heavy equipment standing idle because of inability to effect repairs, lack of spare parts etc. While there is a natural desire in all parts of the world to reduce the drudgery and the strenuousness of farm work, it is usually better to move into an intermediate stage of development - such as the use of animal-drawn equipment - than to pass directly from the hoe to the tractor.

Mechanisation does not of course involve only tractorisation. Especially in the more arid parts of the world there is a dire need for improved mechanical means of bringing water to the fields; this widens the choice of crops that can be grown, brings about increased yields and makes possible double cropping and other forms of more labour-intensive cultivation. Moreover, the Green

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7. For a fuller development of this idea see Keith Marsden: "Progressive technologies for developing countries", in International Labour Review, May 1970; also E. Owens and R. Shaw: Development reconsidered (Lexington, Massachusetts), D.C. Heath & Co., 1972.

Revolution and the various package programmes of agricultural inputs to which reference has been made already are examples of improved technology which can be expected to change the whole face of farming in the years to come and which are applicable to small farms. The paint is to ensure that the new methods are made accessible to the mass of farmers and not only to the more progressive elements. Also, improvements need to be fully suited to the particular conditions of a given country, or of a given locality within a country. This calls for a considerably greater research effort, which, if it is to have the fullest effect, must place much more emphasis than at present on domestic food crops and on livestock and pasture improvement, instead of concentrating on export crops.

There is similarly considerable scope for better technologies for handicrafts and small-scale industries. Equipment, raw materials, design and quality control-all need improvement if these activities are to remain viable in the face of competition from manufacturers operating on a larger scale. In this connection, but also from the point of view of making rural life more attractive, much benefit can be obtained through rural electrification programmes and better systems of providing water in rural areas.

The adoption of appropriate technology is strongly influenced by fiscal and related government policies. If advanced equipment is allowed to be imported on favourable terms and if factor prices are manipulated in such a way as to favour capital-intensive technologies, the latter are likely to establish themselves irrespective of their social costs.

2. Education and training:

The developing countries have in recent years made tremendous strides in extending primary and secondary education, so much so that one of the most difficult problems facing a number of countries is that of unemployed school leavers. Among the reasons that have given rise to this problem is undoubtedly the unsuitability, one might even say the irrelevance, of the type of education given. Frequently the educational system and the curriculum have been transferred without significant modifications from Western to developing countries. Certainly they have generally not served to prepare young people for taking up a job other than a white-collar one, and there are simply not enough of these to go round. (In rural areas the instruction given is typically alien to the environment, and as such does not prepare young people for working in the rural sector;)(on the contrary, it leads these youngsters to ignore farming as an occupation, and to look for jobs elsewhere.)

Much the same must be said about vocational training in a number of countries. Here again training courses for skilled workers and examinations leading to diplomas are based on Western (especially European) models and may bear no relationship to the jobs the trainees will have to do once they start work. International organisations have not been free from mistakes in the vocational training especially in rural areas. The equipment provided was far too advanced and was ill-adapted to the simple needs of the trainees and their future job openings.

These same criticisms may also be levelled against some forms of farmer training being introduced into developing countries. Too often an agricultural extension scheme

is a replica of a Western model and has not been adequately modified to suit entirely different conditions. In North America and Europe an extension system is conceived as an instrument to guide highly educated farmers and keep them in touch with improvements in agricultural science and related matter, whereas in the developing world the extension agent usually has to work with illiterate persons. Moreover, few governments have the resources to maintain an adequate service, and in all too many instances work is too thinly spread, with one agent trying to cover several thousand farmers. For these and other reasons the service, more often than not, reaches only the more progressive farmers and leaves the masses untouched. Moreover, extension activities are apt to be too limited in scope, with insufficient attention being given to economic or social matters. Finally, a good many local extension agents have the wrong attitude to their job: they consider themselves superior and are afraid to get their hands dirty; they visit a farmer wearing a white shirt and tie, and do not speak his language, both in the literal sense as far as the dialect is concerned, and in the other sense of not being sufficiently practical. The better agents soon get disenchanted with work in the field and the poor conditions of employment and seek transfers to the capital.

There are of course brighter sides to the picture: there are examples of agricultural extension services doing excellent work and the same applies to certain supervised credit schemes combining the granting of loans with technical agricultural and management guidance. A number of countries, especially those in East Africa, have also set up farmer training institutes where good basic agricultural training is given. Other countries are training

"Pilot" farmers who serve in their communities as a means of diffusing the improved practices which they have learnt and at the same time act as the point of contact between the community and the agricultural extension and other technical services.

Certainly any rural development programme must include a well-conceived and adapted system of training, including much-improved systems of communication and dissemination, both for the producer and for the various grades of technical and administrative staff required for development work in rural areas.[8]

3. Employment:

A major difficulty in formulating an employment strategy for the rural sector in developing countries is the lack of even the most fundamental data. It is therefore very important to make every effort to obtain as much information as possible on the nature of the employment situation, the patterns of labour utilisation (particularly in its seasonal aspects), attitudes towards employment and income, and so on.

One thing is clear, and that is that the traditional Western concepts of full employment, unemployment and the eight-hour day, for example, are meaningful only within fairly narrow limits.[9] In many rural economies there is no

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8. A thorough study of training for rural development has just been completed by the Internations Council for Educational Development, and a report entitled Non-formal education for rural development is to be published shortly.

9. Cf. ILO: Concepts of labour force under utilisation, by A. Smith, Employment Research Papers, D. 23 1971 (Geneva 1972) mimeographed.

clear distinction between work and what an outsider might interpret as leisure activities, but which are in fact essential parts of rural life. Moreover, there are still a lot of happy people in the world who are satisfied with minimum requirements, and who are not inclined to work harder or longer than is necessary to obtain them. Also there are a number of situations in which nutritional deficiency and poor health act as severe impediments to what a westerner would consider as a full day's or a full week's work. The whole fabric of economic and social relationships in the "informal" sector in developing countries, with the predominance of family labour and small undertakings, is one to which Western concepts of employment are largely irrelevant. A recent article has even questioned whether economic theory as applied to agriculture in developing countries should not recognise that labour is not a variable factor in production but rather a fixed one, and that farmers adjust their use of land and of equipment in accordance with the amount of labour they have available.[10]

(In areas of high population pressure, rural development policy must of necessity encourage the application of labour-intensive methods.) In farming, this would be consistent with emphasis on improving the performance of small farms, since most farm management research shows that output per unit of land is higher on small farms, though not on tiny ones. (The introduction of high yielding varieties of crops may very well lead to a more intensive use of labour because many of the practices that

10. K.C. Abercrombie: "Rural employment, a primary objective", in Ceres (Rome, FAO), January-February 1973.

are required for the successful cultivation of these varieties - such as the heavier application of fertiliser and of water - are labour - intensive, especially if double cropping becomes possible. On the other hand, the Green Revolution may also involve a shift from highly labour-intensive crops such as cotton to less labour-intensive ones such as wheat.[11] And it has to be remembered that there are constraints on the use of labour-intensive techniques - the availability of water, the adjustment of primitive farming methods, etc.

Labour-intensive methods are particularly suitable for small-scale industries in rural areas as well as for handicrafts by definition. Rural people, including family workers, engage in a great variety of occupations in order to meet the needs of the community for consumer goods and services. This is the "informal" sector par excellence. But this does not mean at all that such occupations need to remain at a low level of efficiency: especially in countries at an early stage of industrialisation, the strengthening and expansion of small economic units constitute the most suitable strategy. If such units are to do a better job they need better equipment and raw materials and improvements in design, marketing facilities, and so

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11. For a comprehensive review of the economic implications of the Green Revolution see Keith Griffin: The Green Revolution: an economic analysis (Geneva, United Nations Research Institute for Social Development (UNRISD), 1972); see also Zubeida Manzoor Ahmad: "The social and economic implications of the Green Revolution in Asia", in International Labour Review, January 1972; and J.N. Sinha: "Agrarian reforms and employment in densely populated agrarian economies: a dissenting view", Ibid., November 1973.

forth. Moreover, these industries require encouragement in the form of credit and extension services and other technical assistance.

The extent to which handicraft and small industries will be able to survive and provide increased employment depends on government policy with respect to industrialisation. If it is deemed desirable to maintain small enterprises, then fiscal and price policy must seek to confine capital-intensive technology to cases where it is more efficient in real terms than labour-intensive technology would be. It is of course true that as the rural sector becomes more fully integrated into the market economy there will be more specialisation of labour and a greater concentration of non-farm production in larger units. The latter can, however, be located in rural areas, or modern industries can subcontract the manufacture of components to small workshops or even to households in rural areas, as they have done in Japan.

(Any rural development programme will usually include a rural works component.) Some of these works, such as the building of community facilities, have only temporary employment implications. Others may have significant permanent indirect effects, as in the case of the construction of irrigation works that will subsequently make possible more labour-intensive farming or road building that acts as a production incentive by making marketing easier. Lack of management skill and organisation appears to be the main factor preventing rural works programmes from bearing fruit.[12]

12. Cf. Dudley Jackson and H.A. Turner: "How to provide more employment in a labour-surplus economy", in International Labour Review, April 1973.

The application of labour-intensive policies in the rural sector is limited by a variety of institutional factors, namely, land tenure, credit and marketing and the domination of the big landowners - questions to which we will now turn.

## 4. Agrarian reforms:

Of all the issues related to rural development, agrarian reform has probably been the most discussed, frequently with more feeling than sense. It is now almost 25 years since it became a topic for international discussion in the Economic and Social Council and the General Assembly of the United Nations as well as at conferences of the Food and Agriculture Organisation (FAO) and the ILO. During that time a certain amount of progress has been achieved: a great deal of legislation has been enacted and is a small number of countries effective agrarian reforms have been implemented. But a great deal more needs to be done, as was shown clearly in the report of the FAO special committee which completed its work in 1972.[13] We need to get away from the mysticism and from talk and debate and get down to action.

There is now very general acceptance of the basic premises of agrarian reform: in particular that modern

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13. FAO: Report of the Special Committee on Agrarian Reform (Rome 1971). For further reading see the series of reports of Progress in land reform published by the United Nations; ILO: Agrarian reform and employment (Geneva 1971); Doreen Warriner: Land reform in principle and practice (Oxford, Clarendon Press, 1969); E.H. Jacoby: Man and Land (London, Andre Deutsch, 1971); and Peter Dorner: Land reform and economic development (Harmondsworth, Penguin Books, 1973).

concepts of social justice cannot permit situations in which a small landed elite controls the lives and souls of the masses of the rural poor, and that abuses connected with the concentration of land ownership and the monopoly of economic, social and political power that goes with it must be removed. In countries where such situations still exist there is very little point in talking about rural development in the sense used in this article. Partial remedies are no good; an effective agrarian reform must attack the basic problems at the roots. But this does not mean that a reform must be carried out once and for all: agrarian structures are extremely complex, and it is necessary to keep the situation under constant review and make such modifications and improvements to the reform programmes as are called for as conditions change. Experience has also shown that it is most unlikely that a successful reform can be implemented without the active participation of the rural population in both the formulation and the implementation of the reform measures.

There has been some criticism of the tendency to define agrarian reform in such a broad manner as to include a large number of subsidiary issues which some people feel detract from its essentials. An irrigation scheme, however beneficial, is not agrarian reform. The core of an agrarian reform programme must obviously be adjustments in the structure of land tenure, but this does not at all mean that land redistribution by itself is enough: on the contrary, once the land has been redistributed in accordance with the particular policy adopted by the government a major task still remains; this consists of making available to the beneficiaries a wide range of services and institutions, accompanied by comprehensive training

programmes, such as to permit them to become efficient operators of viable holdings.

The type of land tenure to be introduced following the reform is a matter for each government to decide upon, and certainly there can be no universal model. While many governments favour individual holdings under private ownership, others have adopted various forms of group or collecti tenure, including the producers' co-operatives in socialist economies. Sound arguments can also be made out for state ownership of land with long-term leases to individuals, co-operatives or even corporations; such a system helps to ensure that land is used in the public interest. Co-operative farm production is an attractive idea to many. It should be recognised, however, that in the developing world as a whole co-operatives have not always performed too well (as we shall see below) and problems arise in connection with such comparatively simple forms of joint activity as servicing, marketing and credit. Co-operative production is a much more complicated affair, and it would appear to be hazardous to introduce this without first having established a solid co-operative tradition.

Many people confuse agrarian reform with land settlement. It is true that the international definition of agrarian reform includes land settlement as one of the possible measures, and certainly it has its place in agricultural development, especially in those fortunate countries, such as many in Africa and Latin America, where there are still large areas of land available for development; but in countries where the agrarian structure has serious defects, especially excessive concentration of ownership, the promotion of land settlement will do little to correct these basic defects and therefore to free the

mass of rural workers from the severe constraints on their liberty and opportunities for progress which these agrarian structures imply.)

(The ultimate objective of agrarian reform is to promote access to the land by the cultivator or the worker.) Some reforms, such as those in Eastern Europe, have provided for the immediate abolition of all forms of indirect cultivation, such as tenancy and share-cropping; others aim at an improvement in the conditions of tenants and share-croppers until such time as a complete land redistribution plan can be implemented. It is important to recall that tenancy is not necessarily a bad thing in itself. Some of the most highly developed agricultural regions of the world, e.g. much of Western Europe and the Middle West of the United States, contain high proportions of cultivators who do not own their own land but rent it. In those countries, over the years, systems of tenancy have evolved that give the cultivator a high degree of security while at the same time letting him use his capital to improve equipment and other non-permanent assets, the latter being provided by the landowner. But there is little in common between tenants in such circumstances and those in Asia, North Africa, the Middle East and Latin America who live in conditions bordering on serfdom. For these, the ultimate solution must undoubtedly lie in the abolition of tenancy and share-cropping arrangements and, where this is not immediately feasible, stringent measures to improve the arrangements and make sure that the relevant legislation is effectively implemented. For that purpose it will undoubtedly be necessary to establish effective

organisations among tenants.[14]

In countries where there is very high pressure of population on the land, it will be difficult to reconcile th objectives of agrarian reform with those of employment in the broad sense of the term. In a country like India, ther simply not enough land, at least under the present farming systems and methods, to give every rural worker a viable holding. It is true that the wider application of new technologies, characteristic of the Green Revolution, holds out the promise of making small farm units more efficient, especially in areas where there is an adequate water supply Even so, from the economic point of view, it is important that small farms should produce a marketable surplus in addition to ensuring more adequate consumption for the farm family. Agrarian policies should therefore aim at creating farm units of sufficient size to achieve this; those who cannot benefit from access to land will have to be found employment under rural works schemes and other non-farm activities. In parts of Latin America, where there is more land available per head and where existing holdings especially the large ones, are operated inefficiently, there is considerable scope for devising agrarian reforms in such a way as to meet employment objectives at the same time.[15]

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14. See ILO: Improvement of conditions of life and work of tenants, share-croppers and similar categories of agricultural workers, Report VII(1), International Labour Conference, 51st Session, Geneva, 1967; also the Tenants and Share-croppers Recommendation (No.132) adopted by the International Labour Conference in 1968.

15. See Marvin J. Sternberg: "Agrarian reform and employment with special reference to Latin America", in idem: Agrarian reform and employment; op.cit.

5. Co-operatives and other rural organisations:

Co-operation is another subject about which there is much talk. Too often, co-operatives are regarded as a panacea in the sphere of development, particularly rural development. The evidence appears to show that this is too optimistic a view. Purists among supporters of the co-operative movement spend a great deal of time arguing whether a particular form of organisation should be called a co-operative or not, using as a basis the extent to which the famous Rochdale principles are applied. These principles have great relevance to strategies to help the rural poor one man one vote, refunds in proportion to transactions, open membership but there may well be other forms of group action that can promote development.

It is hardly necessary to recall the very significant role that has been played by co-operatives in Europe and North America. It is largely through co-operative action that very substantial benefits have been obtained by rural people, and the co-operative movement has led the way in introducing a wide variety of technical, economic and social improvements in these countries. There are also significant accomplishments in the less developed countries,[16] but in recent years particularly, there has been increased concern at the apparent inability of co-operatives to do all that is expected of them.[17]

16. See ILC: The role of co-operative in the economic and social development of developing countries, Report VII(1), International Labour Conference, 49th Session, Geneva, 1965.

17. See for example the studies prepared by the United Nations Research Institute for Social Development in its series on "Rural institutions and planned change", published in Geneva, 1971-73.

Part of the reason is undoubtedly the fact that the models of co-operation introduced have too closely followed Western models which grew out of entirely different circumstances and conditions. On the other hand, people who argue that co-operatives in developing countries must emerge from or be based on indigenous and traditional groupings perhaps go to the other extreme: although it has been shown that some traditional structures may in fact lend themselves to the needs of modernisation, there are others which by their very nature prevent progress. One of the main criticisms of co-operatives is that in certain countries they have not catered for the needs of the little man, whereas this was of course the fundamental objective of the societies which emerged in Europe during the nineteenth century. In India, only a very small proportion of total agricultural credit is handled by co-operatives, and of this small amount only 15 per cent goes to farmers having 5 acres or less.[18] In several African countries, however, co-operatives are providing small producers with highly significant marketing and credit services.

In many developing countries the co-operative movement had, in its formative stages, to rely on support, financial and other, from the government. The assumption was that in due course this support would become unnecessary; this has sometimes happened but other movements have not yet developed sufficient strength to stand on their own feet.

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18. Government of India, Planning Commission: Study of utilisation of co-operative loans (New Delhi, 1965), p. 169.

(In order to improve the performance of co-operatives, a major effort is required in the field of co-operative education and training, for staff and officers of societies and also for the general membership.) Along with this the movement must improve its management so that societies become more efficient and competitive with middlemen who take advantage of their monopolistic position. It is, however, an over-simplification to criticise all middlemen as parasites. Some of them do perform useful functions which nobody else is taking care of; and, considering the risks and high cost of these functions, their charges may not always be unreasonable.

The support by the State to which reference has been made, is closely related to two other features, compulsory membership in co-operatives and active intervention in their activities, both of which are contrary to the established principles of co-operation. These features are to be found in certain agrarian reform schemes, for example, where the beneficiaries are required to join a co-operative which is managed by an appointee of a government department. The justification for this is that people need to get used to the idea of co-operatives, and that to begin with the societies and financial help and guidance, which implies also some control, even though the ultimate aim is to have voluntary membership and an independent movement. It remains to be seen whether in fact such an evolution will take place.

One of the most striking gaps in the developing world is the small number of representative organisations of rural workers, be they trade unions or peasant organisations. European experience has been that such organisations

have a vital role to play in rural development especially the rural poor.[19] The comprehensive employment strategy missions carried out by the ILO have found it extremely difficult to obtain the views of the rural masses in analysing employment problems in the countries visited, simply because there were so few representative organisations with whose leaders they could talk. The organisation of rural workers has run into considerable difficulties in the developing world; not only has the right to organise been questioned but even when it is legal, there has been strong opposition, in many cases accompanied by violence on both sides. A big effort is needed to devise suitable forms of organisation for rural workers; this is an effort in which urban trade unions, the international trade union movement as well as other voluntary bodies have an important role to play.

6. Rural incomes and amenities:

(The ultimate objective of a rural development strategy is of course to increase the incomes of the rural population and improve the way they live and work.) The measures referred to in preceding sections should in one way or another contribute to this purpose. It needs to be recalled in this connection that in most developing countries the gap between rural and urban incomes is widening and that the bulk of the poor are to be found in rural areas. Higher incomes are therefore a matter of priority in terms of social justices; but they are also essential

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19. For a comprehensive study in this field see ILO: Agricultural organisations and economic and social development in rural areas, by Xaviar Flores, Studies and Reports, New Series, No. 77 (Geneva, 1971).

for economic development, which stands little chance of succeeding unless the purchasing power of the rural majority of the population is raised.

The question of farm incomes is an extremely complicated one, and has many facets, ranging all the way from the elaboration of suitable price policies, to means of reducing the spread between the prices paid by the consumer and those paid to the producer. Two points need to be raised in connection with income security for the less advantaged farmers. The first is the granting of some degree of protection against loss of income due to natural hazards such as drought, floods, frost, crop diseases and pests, which can result in a complete loss of livelihood for the small farmer. A number of schemes, including crop insurance schemes, have been developed to grant some compensation for such losses. These schemes are still largely at the experimental stage and are by no means adequate. It may also be necessary as a corollary to the introduction of improved farming techniques to give the small farmer some protection against the risks of innovation. One of the reasons why the small farmer hesitates to introduce new practices is the fear that his yields will not come up to expectations and that his income will therefore drop. It should not be too difficult to devise schemes which would guarantee the farmer an income based on past yields.

The question of maintaining an adequate wage structure in farming in developing countries is a particularly thorny one. Although minimum wage regulation is being slowly applied to agriculture, there are a number of difficulties. Apart from large plantations and other commercial undertakings, most of the farms employing wage labour are small and the farmers' capacity to pay is rather

limited. In addition, much of the agricultural wage labour force is seasonal and casual, and farms are scattered and engage only one or two workers each - all of which makes the application of legislation extremely difficult. The problem is accentuated in areas of heavy population pressure since this leads to an increase in landlessness and in competition for whatever jobs may be available. The same situation prevails, by and large, in the case of other small enterprises in rural areas. The spread of new technologies and particularly package programmes of inputs associated with high-yielding seed varieties may offer some prospects of higher wages because of their greater labour intensity and the resulting greater demand for wage labour, but so far the evidence is not conclusive, although it is obvious that as farming and other rural occupations use more advanced technologies, the demand increases for workers with certain specialised skills (e.g. tractor drivers) who can command higher wages.

The incomes of tenants and share-croppers, who constitute a very large proportion of the labour force in many developing countries, depend on the way in which the proceeds of total farm income are distributed between the landowner and the tenant or share-cropper. Tenancy reforms, to which reference has already been made, are partly designed to lead to a more equitable distribution. Here again, there are difficulties of application, particularly where there is such a hunger for land that tenants outbid each other irrespective of legislative provisions. Also, and again in connection with the Green Revolution, there are some indications that large landowners are turning towards direct cultivation (using mechanised methods) and are evicting their tenants. Tenancy regulation within a framework of agrarian reform is a continuing need, not

only to maintain the tenants' incomes but also as a means of providing more incentive, through greater security of tenure, for agricultural improvements. The enforcement of tenancy legislation will be facilitated to the extent that peasants establish suitable organisations to protect their interests and through which they can participate in implementation.

The lack of social and welfare services and amenities in rural areas, not only in developing countries but in the world at large, is well known. The situation is particularly serious in developing countries however, where the resource level is very low to start with and a more-than proportionate share is allocated to urban areas. Much greater efforts need to be made to prevail on central government departments to show more concern for the rural sector and to make a larger provision in their budgets for this purpose. A strengthening of local government machinery is also required. Moreover, it is not enough to merely provide facilities and amenities; it is also necessary to staff them, and there is a universal problem in finding technicians and administrative staff willing to work in rural areas, especially where amenities are lacking. Hence the need to devise appropriate incentive schemes. In some countries university graduates in such fields as medicine are required to serve in a rural community for a certain period before embarking on their careers.[20]

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20. The Kenya employment mission recommended that "at the end of the upper secondary education all pupils should serve the community in their home area for a minimum period of one year as an integral part of their educational career" in such fields as rural works, statistical surveys, health and education. ILO: Employment, incomes and equality, op.cit., pp. 247-8.

One means of ensuring that country people have access to a wide range of technical, economic and social services is to establish strategically located centres in which the various services would be made available. One can conceive of a rural development centre, possibly in a market town, where the farmer would find the local official of the agricultural department, the extension agent, the credit institution and the co-operative as well as the doctor, the social worker and so on. This would also be the place where the secondary school, the experimental or demonstration farm, the agricultural machinery repair and service station and so forth, are located. Such an arrangement would not only make life easier for country people but could lead to the establishment of a community with the necessary amenities which would act as incentives for government officials and others to work in the country.

Great hopes were placed in community development in the 1950s and early 1960s; much was accomplished at the local level in getting the people more involved, in undertaking village improvements, in developing a grass-roots approach. But there has been some disenchantment in recent years: efforts were too localised; they concentrated too much on welfare and too little on economic activities, even so hardly touching the most underprivileged groups; there were difficulties of co-ordination between new government agencies and well-established technical services. However, the interest which community development activities aroused certainly helped to draw attention to the many grave problems with which rural areas in developing countries are confronted.

## C. Conclusions

It is evident from what has been said above that rural development is an extremely complex matter. To accomplish everything that has been mentioned in the earlier sections represents an ideal that will probably not be attained soon, if at all.

An endeavour has been made to show the inter-relationship between the various components of a rural development programme and to demonstrate that an integrated approach is therefore necessary not only within the rural sector itself but also in order to take account of the close interdependence between agriculture and non-farm activities in rural areas and between the rural and the urban or industrial sectors.

It seems to be clear that in the developed countries marginal small farmers - and probably peasants, are likely to disappear from the scene before too long because there is no place for them in an increasingly industrialised society with a rapidly decreasing agricultural labour force and a need to ensure agricultural production through fairly large and heavily mechanised units. This disappearance will increasingly raise serious problems of maintaining adequate services in rural areas for a dwindling population. In the less developed countries, this stage of development is not likely to be reached for some time: there the essential need is to develop a progressive rural sector offering a variety of employment and producing more efficiently, so that incomes can be increased and a wider and more complete range of amenities supported. In such rural economies the level of technology, the institutional base and the educational process must be adjusted to local

conditions - more specifically to the needs of the rural poor. It is through an increase in the incomes of the latter, who make up the bulk of the population, that sufficient purchasing power will be created to enable domestic industry to expand and to lead to a better balance between the rural and urban sectors and between the traditional and the modern. Such a development will pave the way for a higher degree of industrialisation, which is the ultimate objective for most countries, and it is at that stage that it will be possible for "peasants" to become real "farmers", as Weitz has stated.[21]

But how is this to be achieved? There is the approach of the technocrats on the one hand and of the reformers on the other.[22] The technocrats give priority to growth through an increase in production by the more progressive elements; the reformers place the emphasis on creating an appropriate social climate which will enable the masses of rural workers to benefit from improved techniques. The answer probably lies in a good mixture of both approaches.

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21. Raanan Weitz: From peasant to farmer: a revolutionary strategy for development (New York, Columbia University Press, 1971). By this he means that subsistence farmers will become fully market-oriented and will develop appropriate systems first of mixed farming and then of specialised agriculture, as has happened in highly developed agriculture in many of the industrialised countries.

22. E. Feder: The rape of the peasantry (New York, Anchor Books, Doubleday and Co., 1971).

## Chapter II

## ON THE CONCEPT OF INTEGRATED RURAL AREA DEVELOPMENT

"Integrated area development" is repeatedly referred to by planners, administrators and men in public life. Not all of them, however, fully appreciate the meaning and implications of it. This chapter explains the concept of integrated area development.

### A. Concept of area:

What is an area? The question appears to be naive, for everyone believes he knows what an area is. According to Oxford dictionary, it means 'extent of surface cover', region, tract, etc. So simple indeed appears to be the problem. Yet, despite several decades of efforts by planners, they have failed to arrive at a definition of 'planning area' acceptable to all.

'Area' is undoubtedly a geographical concept. It signifies an extent of space. It is measurable and definable. Its limits are determined by the attributes which go into its formation. These attributes may be natural or human.

Geographers have done considerable work on the scientific theory of areal classification. This work usually appears under the heading regionalization or regional typology. Those of us interested in knowing more about typology of areas should consult literature pertaining to regions. The typology suggested by Brian Berry, an American geographer, is given in fig. 2.1 with some modifications to suit Indian conditions.

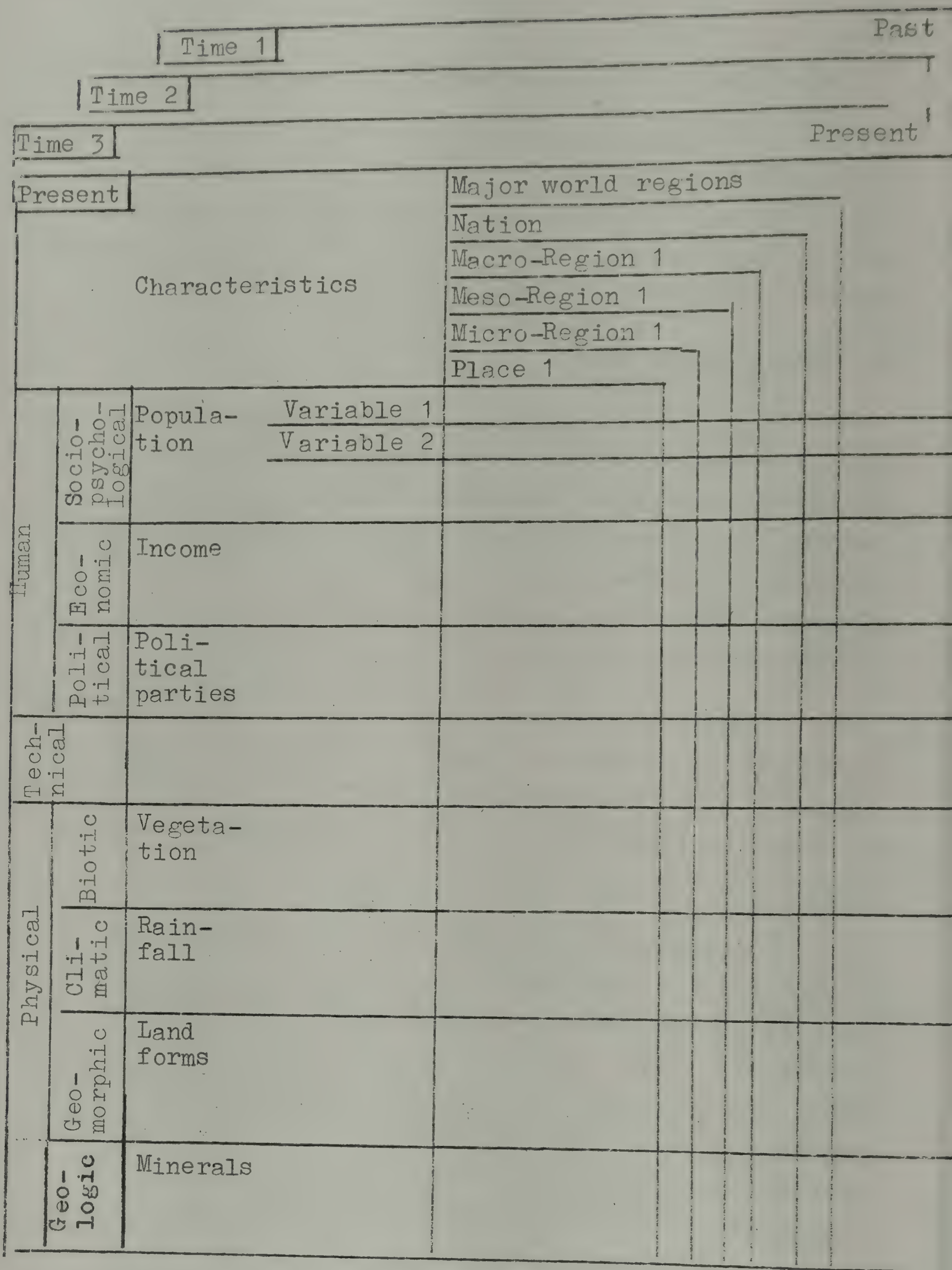


Fig. 2.1: Regional Typology.

The scheme presented above tells us that regions can be arranged in a hierarchical order. The largest region in a country is the country itself. It can be divided into several macro-regions, which can in turn be divided into meso-regions. The meso-regions also can be divided into micro-regions, which in turn can be divided into places. Starting from the bottom, places with certain common attributes can be grouped together to form a micro-region; the micro-regions to form a meso-region; and the meso-regions to form a macro-region.

It is clear from the above table that different attributes would give different regional schemes for the simple reason that these attributes are not equally or evenly distributed over the space. We would discuss this question of regionalization further in a later chapter.

In India, a planning area is generally co-terminous with a micro-region. It is an aggregate of 'places', with common attribute(s). For example, a taluk/tehsil is taken as a unit for rural area development, because of its administrative unity. The attribute to identify the area is administration. Administrative convenience is often the major consideration.

Thus the areas for planning can be of two types:

i) Based on scientific regionalization; and
ii) Based on administrative convenience.

Both the types have their merits and demerits. We can incorporate the good points of both while selecting an area for planning. We would discuss this in the next chapter. Here suffice it to say that a district or taluk or a community development block is as good a planning area

as a watershed, a river basin, an urban region, etc. It all depends on how we approach the problem and resolve conflicts.

B. Concept of development:

Development is another term which we use rather loosely. We often use the terms 'economic growth' and 'economic development' interchangeably. We, however, never use the term 'social growth'; we always say "social development".

Growth usually refers to quantitative increase or expansion in size. If our industrial production doubles, we have grown twice industrially. Similarly, if agricultural production doubles, then we have achieved hundred per cent growth in agriculture. The development, however, means more than growth; the growth component is present in development too, but unless it is accompanied by certain structural changes in the production process, it cannot be called 'development'. The structural changes must be consistent with the national/regional goals and objectives. Who produces and how? What is produced and how much? Who benefits from the production and to what extent? These and other questions come up prominently in the development context. If growth is accompanied by changes in the ownership of means of production, more equitable distribution of production and profit, strengthening of the base for further production, technological development consistent with socio-economic realities, better methods of planning and allocation of resources, better management, etc., then alone, it is development.

An important point to note here is that growth is essentially a mechanistic process and can be achieved at the cost of human welfare. While it is true that it is

possible only if people participate in the production process, it is equally true that in a fast changing technological situation, need for participation can be minimized and in a semi-feudalistic social system, it can easily be forced upon the people. As against this, development is essentially humanistic and matches economic growth with institutional changes. Development is all embracing and cannot be achieved alone by greater investment in the economy. It is a product of the value system, social organization, political system, economic institutions, technological achievements and other related phenomena. They must change to support each other and to meet the objectives of a developing society which can be no other than human welfare in its broadest sense.

The above definition explains well why development cannot be achieved in a year or a decade. It is a slow process because it calls for changes in human beings, their institutions and values. It is as much a matter of investment in man, as that of investment in material goods. It is as much a product of investment in education, health, land reforms, minimum human needs to mention a few, as in agriculture, industry, transport, etc. Development depends on the following major factors:

1. national goals and objectives;
2. willingness of the people to sacrifice the private gains for social gains;
3. integrated planning and optimum resource utilisation for rapid economic growth and social justice;
4. socio-political stability to carry out the development objectives; and
5. committed leadership and development administration.

C. Concept of rural:

The term 'rural' is better understood when juxtaposed to 'urban'. Rural is essentially an area with dispersed settlements surrounded by agricultural activities. As against this, urban is an area marked with agglomeration of people and non-agricultural activities. This, however, does not mean that in a rural area, there are no urban places, or in an urban area, there are no villages. In between the pure villages and pure cities, there are 'rural towns' and 'urban villages'.

The urban and rural areas of a country cannot exist independent of each other. They are interlinked socially, economically and otherwise. A city cannot grow without the support of its rural hinterland. On the other hand, cities act as focal points for the management of vast areas of dispersed rural settlements. They are also centres of change at least in some respects.

One should also not forget the fact that rural and urban areas are closely linked with each other economically. Many rural products find market in urban centres, and the vice versa is also true. If the terms of trade, because of price mechanism or policy are in favour of the urban areas, as is the case presently, rural areas become areas of exploitation. Unless we prepare plans which take care of the rural and urban areas and their problems in an integrated fashion, the dualistic nature of development would continue.

This means that when we plan for rural areas, we should not neglect the urban centres within such areas or outside, having influence on them.

D. Concept of integration:

We often talk of integrated planning and development, but more often than not, we are not sure of its implications and substantive meaning. As we saw earlier, development is a multi-dimensional phenomenon. Every aspect of life and human activity has to change in the development process. This means that if we attempt a change only one or a selected few activities, our progress would be slow. This would happen because the staticness of other activities would render the progress of selected activities tardy and slow.

Each activity has its forward and backward linkages. Its development depends quite substantially on the development of other linked activities. That is the reason why it is often said that "an area is poor because it is poor". If we want to improve the income levels of the people of an area, we must increase their productive capacity. To increase productivity, we must educate and train them: which in turn means that we should have educators and trainers, and training facilities, which also means that we should have facilities to train the trainers. Similarly, to have better equipments and more investment capital for higher productivity we have to develop a variety of other activities.

Heman life, as we all know, is an integrated whole. Man is an individual, he is a social being, he is an economic being, he is many other things at the same time. Development of man, therefore, means all round development. We cannot develop the man, if we treat him as an unintegrated personality. Same is the case with an area too. Integrated planning, therefore, means planning for

the development of all aspects that impinge on the subject of development simultaneously.

This, however, does not mean that nothing can be done unless everything is attempted at the same time. Among the various elements of development, some are more important and catalytic than others. Moreover, some can be developed only when some others have reached a certain stage of development. We should, therefore, fix priorities and determine what to develop when and with what intensity and speed without forgetting the underlying linkages among various activities. This is called sectoral-cum-temporal integration.

There is another aspect of integration which we should not loose sight of, especially if we are engaged in area development. That is spatial integration. As we have linkages among various activities, we have linkages among various places which constitute an area. There is a constant flow of people and goods among these places. We can change the flow by investing in some places more than at other places or by locating activities at some places but not elsewhere.

We should therefore attempt a spatially integrated plan in such a way that every place is able to develop itself to the fullest extent and no place is allowed to exploit the weaknesses of other places. We should not forget that a place has a meaning only when there are people. The neglect of a place means the neglect of people.

A third aspect of integrated development concerns the individuals and groups of people. As it is often the

case, in countries like India some people are much better off economically, socially, etc. than others. They are in a better position to benefit from whatever developmental activities are created and generated than the majority of the people who are poor and illiterate. It is quite serious a problem in countries like India, which still have a hang-over of feudal structure of the past. Integrated development in this context then essentially means the development of the poorer sections of the population, so that they become equal partners in national and regional development.

A final and equally important aspect of integration involves the integration of conflicting goals of economic, social and environmental development. Economic objectives of development must be in tune with social and environmental objectives, but in a poor country like India, the environment for the pursuit of economic objectives is more favourable than for the social and environmental objectives. The nature of integration of these would vary from one stage of development to another, but integration as such cannot be left to the mercy of the market mechanism or future generations.

<u>Summary</u>:

Having discussed the meaning of every term used in Integrated Rural Area Development, we now propose to throw some light on the overall concept of it. In means planning and development of an area which, in India, is not larger than a district, which is predominantly rural in character. It is a scheme of comprehensive development covering all aspects of life and human activities giving priorities to those which can prove catalytic but without neglecting others. Integration has to be achieved among various

sectors and subsectors of activities, among various places and sub-areas, among peoples and groups, and among conflicting social, economic and environmental goals.

We would examine later, the principles on which an area for rural development is selected. It may, however, be mentioned here **that** it should generally not be larger than a micro-region. Of course, the exact size would depend upon topography, resource endowments, population distribution, existing infrastructure, etc.

## Chapter III

## SELECTING RURAL AREAS FOR INTEGRATED DEVELOPMENT*

In the earlier chapter, we noted the basic concepts underlying integrated rural area development. In this chapter, we propose to discuss the principles which govern the selection of areas for integrated development. The reader may be forewarned here that no single principle discussed below can be religiously accepted by planners. Which principle or set of principles should be used, would depend upon the local situation and the main thrust and strategies adopted by planners and policy makers.

As noted earlier, the real world is made up of an immensely complex mosaic of places, areas and regions. Each specific purpose or criteria would give a specific set of areas. There is thus no single or generally accepted set of areas or regions that forms a Linnaean system for area or regional development. Rather, there are alternatives each with certain strengths and weaknesses. The most successful types of regional or areal units appear to be those whose spatial boundaries coincide most closely with the ecological or socio-economic systems described.

### A. Principles of Areal Differentiation

#### 1. Principle of Homogeneity:

Homogeneity in the distribution of a particular phenomenon is one of the principles of areal differentiation. An area populated by tribal population could be [illegible] as a tribal development unit. An area which has major

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* Partly drawn from Peter Haggett, Geography: A Modern Synthesis, NY: Harper Row, 1972.

parts of its land covered with forests, could be an ideal area for planning of forest resource development. Similarly, an area where majority of people have less than national average per capita income can be a unit for planning with accent on poverty removal. An area which is often subjected to droughts, would be an ideal unit for drought prone area development planning. One can cite many more examples.

## 2. Principle of Ecosystem Cohesion:

In physical geography, the watershed along with its living community of plants and animals, including man himself, constitutes an areal or regional system. There are four major advantages of treating such life communities as ecosystems. First, regional ecosystems are monistic in that they bring together in a single analytical framework the plant and animal world, the rest of the physical environment, and man himself. Second, they are structured in a more orderly and therefore comprehensive way. Third, ecosystems function inasmuch as their structural cohesion depends on continuous cycling of material and energy. Further, regional ecosystems possess certain common features with other systems so that modelling methods applied to other systems, as in engineering or physics, can be extended to ecosystems.

We can also think of a city and its rural hinterland as a city region in systems terms. As with watersheds, city regions need a constant flow of energy for their maintenance. If we cut off the movement of people, freight or funds in and out of the city, it will stagnate; if we increase these flows, it would grow in size.

3. <u>Principle of Complementarity</u>:

This principle is used to differentiate areas for planning when two or more sub-areas are so complementary to each other that they cannot be considered in isolation. For example, one region produces coal while the other iron ore. Both depend on each other for development. One may also use the complementary character of rural and urban areas. Or, one may consider a river basin the upper reaches of which can be used only for aforestation and related activities to conserve soil and water, while the middle and lower reaches can be better utilised for crop farming. We must plan for the whole river basin and make the people living in the lower reaches having irrigation facilities for crop raising to pay for the soil maintenance measures in the upper reaches.

By using the principle of complementarity, we can carve out areas and regions for planning which would generate adequate resources for development. The surplus of the rich sub-area can be invested in the poor sub-area; and the cheap man-power of the poor sub-area can be fruitfully utilised in the rich sub-area.

4. <u>Principle of Viability</u>:

Another principle which is used in the delineation of planning area is that of viability. The question that is posed is viability in what? Unless we answer this question in concrete terms, we cannot make use of this principle effectively.

To answer this question, let us take a village with 1,000 population having an average per capita income of

Rs.800/-. We have to plan for the development of this village. At the moment, let us not bother about other details and the implications thereof for planning. This village may need many things - better housing, drinking water supply, diversified agriculture, health facilities and so on. While a few things could be done by the government at their own cost, the cost of many others would have to be partly borne by the people. What is the capacity of the people to absorb the cost? Moreover, one cannot provide a health centre for a community of 1,000 people. It would not have the population threshold to work efficiently. Thus, certain activities and facilities can be created only if there is required population and demand threshold and many activities can be created only if the community is in a position to absorb the cost.

We can now further postulate that the size of the area for planning essentially depends on what we want to do, which in turn depends on what people want and what our capacities for development are. Thus a viable area for planning is one wherein a given set of activities can be planned and developed. In the context of rural development, the viable area must be able to provide college level education, health services with hospital beds, agricultural and industrial training facilities, good agricultural marketing service, extension service, etc. An ideal area for integrated rural development would cover a population of about 100,000. This would mean about 20,000 families, and if taken an average of 100 families per village, the total number of villages would come to about 200.

5. <u>Principle of Administrative Convenience</u>:

As already mentioned earlier, administrative boundaries often become the boundaries for planning area. This happens because of several reasons, the important among them are:

1. Data required for planning are more readily available for administrative units,

2. It is easier to implement a plan if the administrative and planning areas coincide.

3. The empirical knowledge about the area and its problems is more readily brought into the planning process, if the traditional administrative machinery is closely associated with planning and development activities.

4. In a society like ours, the law and order as well as revenue authorities can intervene in favour of the weaker sections and help them to receive the benefits of planned development.

It is because of one or all of these considerations that in most developing countries, planning areas follow the administrative boundaries. It has its obvious disadvantages. At times, the very purpose of development administration is lost and the bureaucratic rules get precedence over achievement of goals and objectives.

6. <u>Principle of Functional Linkages</u>:

It is quite obvious to us that all human settlements are linked with each other functionally. We have discussed this point earlier too. But we also know that these linkages weaken as distance increases. This is known as distance decay function. Let us take the example of a city

like Mysore. The people living in the rural hinterland of Mysore have close affinity with the city. We can see hundreds of men, women and children bringing their dairy products and vegetables to sell in the city market and returning back in the evening with little cash or some goods of urban origin. Quite many rural people are employed in urban activities. Closer the people are to the city, greater their linkages with it. As distance increases, linkages weaken. The villages in the urban field of Mysore city i.e., which are closely linked to the city, constitute the nodal region or area. When we demarcate the regions of all nodal centres, we can cover the whole national space.

As we would see later, human settlements vary in size and functional specialization. They can be arranged in a hierarchical order starting from a tiny village to the largest megalopolis. They together form a continuum. The area of influence of a small village is the area cultivated around the settlement. A small town extends its area of influence far beyond to cover many villages. A large town must have a far wider area of influence covering many small and medium size towns apart from hundreds of villages. Since there is hierarchy of human settlements, there must be a hierarchy of nodal or functional regions.

## B. Areal Typology

Using the principles discussed above, we can evolve different systems of regions or areas depending upon the criteria chosen for regionalization. It could be illustrated more meaningfully graphically (fig. 3.1).

As seen from fig. 3.1, there are two main procedures for identifying planning areas. One is grouping and the

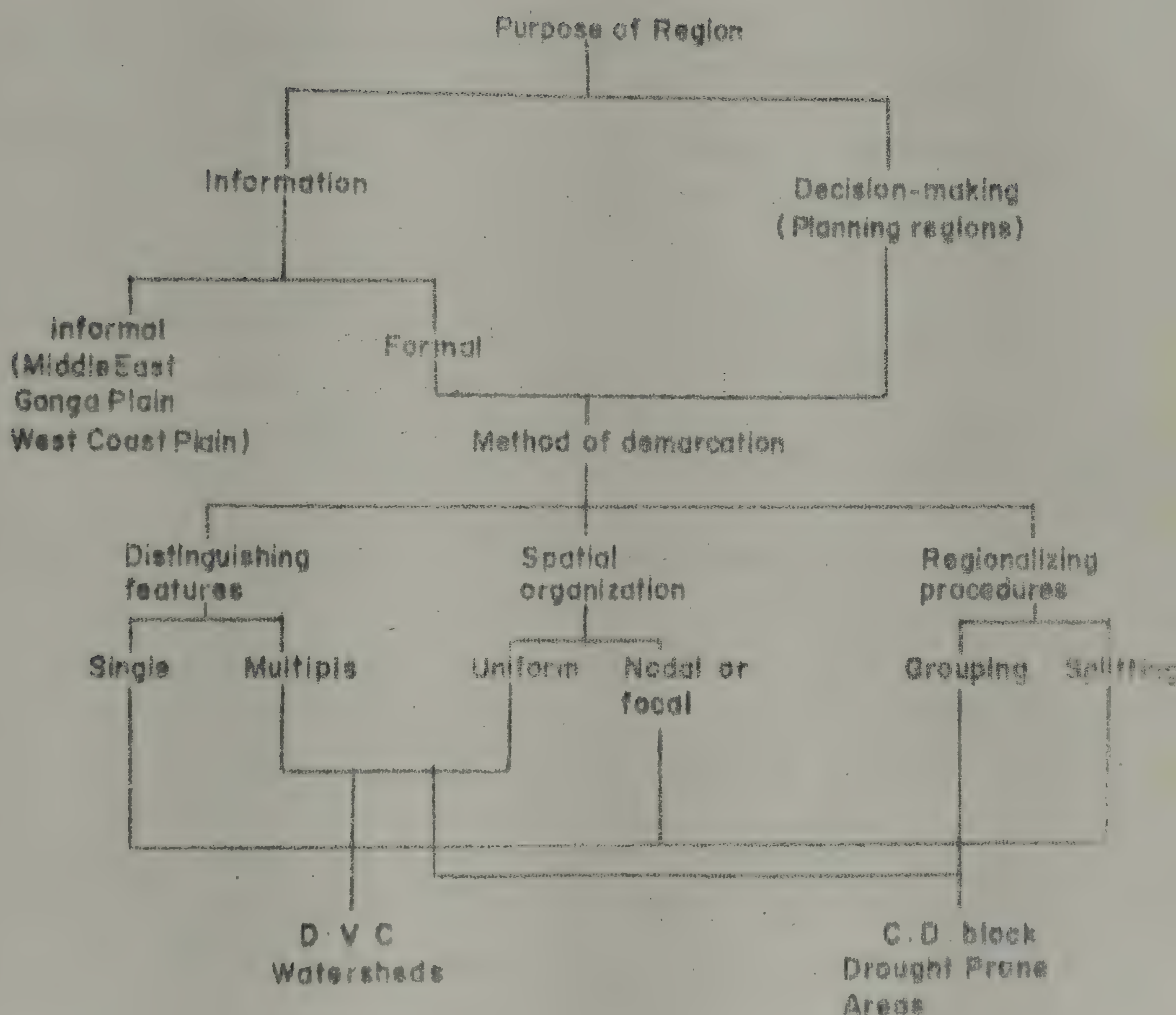
Purpose of Region
Information
Decision-making
(Planning regions)
informal
(Middle East
Ganga Plain
West Coast Plain)
Formal
Method of demarcation
Distinguishing
features
Spatial
organization
Regionalizing
procedures
Single
Multiple
Uniform
Nodal or
focal
Grouping
D V C
Watersheds
C.D block
Drought Prone
Areas

Fig 3.1

other is splitting. Splitting means division of a larger area into smaller components using a set of criteria. Grouping means, putting smaller units with common attributes together to constitute a viable unit of planning.

For the purposes of rural development, it is preferable to think of a planning area derived from grouping of villages. One can do the other way round also. We propose to discuss here how grouping can be done for integrated rural area development planning.

In a pedestrian and bullock cart society like ours, all the elements of a 'farming locality' should be available within a radius of no more than 5 km. These elements according to Mosher are:

i) a market centre providing markets for farm products and retail outlets for farm supplies and equipment;

ii) adequate roads, both to connect the farm within each locality to its market centre and to connect its market centre with the outside world;

iii) local verification trials of supposedly improved farm practices;

iv) the services of an agricultural extension service and

v) access to farm production credit.

The above are in addition to those elements which are needed everywhere such as the agencies to maintain law and order, service institutions like schools, health centres etc.

The five basic elements are highly complementary.

There is little point in improving market outlets for farm products unless there are locally proved methods of increasing production (local verification trials) and unless the farm supplies and equipment needed to increase production are locally available. Improving roads has little consequence unless there are services nearby which, when connected with farms, can lead to increased production. An extension service is of minimum effectiveness except in localities where all of the other four elements are present. It is this high complementarity among all of these elements that makes it desirable to treat the creation and strengthening of farming localities as a single combined activity.

The farming locality with a market centre which should preferably be called service centre should be the fundamental unit for local planning. If these basic units are well identified, grouping of them to form a micro-planning area is not a difficult task. Moreover, it then becomes easier to reconcile the planning boundary with the administrative boundary. The grouped service centres, should have a common higher level facilities to feed them. Mosher calls them facilities for regional servicing of farming localities.

In addition to other facilities, Mosher lists five kinds of district servicing (by district he means an area larger than locality).

1. District (wholesale) markets for farm products and for farm supplies and equipment;
2. Regional agricultural research;
3. District extension administration;
4. District banks; and
5. District roads and communication.

Because of the grouping procedure adopted in the formation of farming district, every rural community is well served by the services it must have. Such an arrangement leads to the matching of hierarchy of human settlements (villages, towns, cities) with the hierarchy of the functions (marketing, extension services, etc.)

## C. From Theory to Practice

In actual practice, not many of the principles discussed above are really used by administrator planners. While regional scientists go on suggesting optimum regions and areas for planning, the administrator planners continue to adhere to administrative boundaries. A careful study of the problem, however, leads to an interesting conclusion. There is no real conflict between the scientific and administrative approach.

Planning activity consists of two major components

1. Plan formulation, and
2. Plan implementation.

Plan formulation process can be facilitated if there are adequate data on resources and feasible activities in a given resource context. We have noted earlier that the boundary of a region or a system of regions is determined by the criteria of regionalization. There will thus be as many sets of regions, as the criteria. It is difficult indeed for an administrator planner to reconcile all these and work out planning regions. He, therefore, resorts to the easiest method, i.e., accept administrative units as planning units.

This practice is likely to continue for years to come. There are some merits in it. But it should be

clearly understood that knowledge of the principles of regionalization discussed earlier is indispensable in order to make a plan, within an administrative unit, a success. While an administrative unit has the advantage of being a suitable unit for administering and implementing a plan, it cannot, by any means, be considered a suitable unit for plan formulation.

To illustrate the above point, let us take the case of an area (figure 3.2) with extensive soil erosion problem.

It is apparent that the root cause of the problem of soil erosion is the deforestation of the upper reaches of the rivers. Unless the forests are restored, the soil erosion and flood problems would continue. But the administrative boundary does not contain the upper reaches of the river within its limits. Effective soil conservation is possible only if the river basin as a whole is taken for planning. What has to be done in which part and place of the river basin has to be identified. Once it is done, the implementation can be done within the framework of the administrative boundaries and using the existing administrative infrastructure.

Thus, we note that for the study of problems and identification of projects, we cannot depend on administrative boundaries. For these purposes, natural or functional regions, or even other types of regions depending upon the problem to be encountered, are more useful. But the activities or problems which are essentially rooted in the administrative unit, can be handled within administrative framework without any difficulty. For example, the watersheds which do not extend beyond the administrative boundary can be planned efficiently within the framework of administrative regions/areas.


Administr
Area of S
Riverbasi
Towns
Villages
River

Fig. 3.2

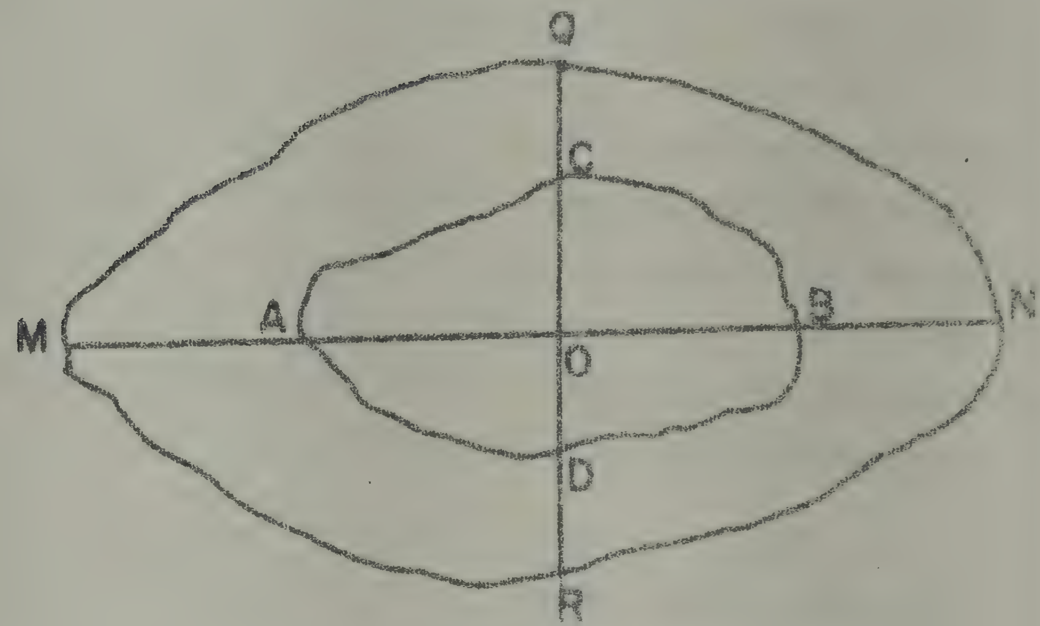
Q
C
M
A
O
B
N
D
R

Fig.3.3

## D. Resolving the Conflict

The question then is, how to resolve the conflict between administrative and other regions to improve area planning processes? We can offer two suggestions here:

i) For regional studies, which must precede regional planning and plan formulation, we should adopt non-administrative regions as suggested above. The implementation of the plan should be done within the framework of administrative regions.

ii) Alternatively, the following procedure should be adopted. Select the administrative area for planning. Draw two vertical (CD) and horizontal (AB) lines cutting each other at O and dividing the administrative unit into four equal parts (see fig. 3.3).

Extend OA = AM and OB = BN; Similarly OC = CQ and OD = DR. Join MQ, QN, NR and RM to get the shape of the ACBD area. By doubling the radius, we have quadrupled the area, because the area of a circle is = $2 \pi R^2$. $\pi$ is common to both smaller and larger figures. When R = 2 km and the area is = 12 sq.km. When R = 4 km, the area would be = 48 sq.km., four times the smaller area.

It is suggested that while planning for the administrative unit ACBD, a larger area MQNR be taken into account. The idea is not to prepare plan for the larger area. It is to keep the natural, human and economic facts of the surrounding area in consideration while planning for the administrative unit which is essentially an arbitrary unit.

Let us give some examples. Supposing that there is a market centre K outside ACBD. It can very well serve the purpose of the villages in its vicinity on both sides of the border. There is no need to develop a market centre afresh. If a river originates in the larger area and flows through ACBD, the planning organization could ask its counterpart in the upper reaches of the river to take up river training projects and both areas can participate in it. We can take a third example of roads. The road network of the planning unit ACBD cannot be independent of the network beyond this area. The planner should know the network of the larger area, the proposals for future, etc. so that he can link up his programme of road development with that of the surrounding areas.

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Chapter IV

# HOW AN AREA DEVELOPS?*

Planners are yet to understand in clear terms the processes which lead an area or region to develop rapidly. Instances of areas developing fast, of remaining stagnant or of sliding back in development are in legend. The catalytic force which transforms an area is perhaps not one, may be, it is a set of interrelated forces which make an area grow and develop. The only way we can understand the processes of development in definitive terms is to study the processes of change for a long enough time. Unfortunately, our ad hoc approach to development without much co-ordination and feedback, does not provide the ideal situation for planning studies of this type.

The group of factors which appear to be responsible for development of a region or area are:

1. Key national, and in some instances international factors; these are the change-initiating forces which influence the volume and composition of local, regional and national economic activity - changes in taste, income distribution, technology, governmental policy and organisation.

2. The requirements of major productive sectors and the factors behind their locational and production decisions.

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* Partly drawn from Harvey S Perloff. How an Area Develops, N.Y: Committee for Economic Development, 1969.

3. The factors behind the employment and consumption decisions of individuals and families.

4. The nature of the individual regions, including such factors as resource endowments, levels of skills of the labour force, internal market, size and other factors which add up to what might be called the "relative cumulative advantage" of each region/area.

5. The amount and efficiency of the social infrastructur available in the area.

6. Degreee of political mobilization for and popular participation in developmental activities; and

7. Confidence and pride in one's capacity to achieve the goals.

## A. Change-Initiating Forces

The secular and cyclical forces of the closely knit national economy have an important effect on economic development in every part of a country. The rates at which new plants are built, new investments in agriculture is made, new job opportunities are created, the expansion and contraction of governmental activities - these and related factors have a direct bearing on the rate of growth and speed of development in various parts of the country.

As the national income increases and distributive justice is enforced, the family incomes rise. These changes lead to changes in demand for various goods which in turn tend to generate new activities. A regional plan must be sensitive to such changes. The pricing and transport policies at the national level also affect the pattern

of development of a region. The prices of agricultural inputs like fertilizers and of products like wheat, rice, etc. fixed at the national level would influence the decision of individuals about what to produce and what to consume.

More often than not, in the developing countries many socio-economic reforms are carried out only at the instance of the Central government. This has been quite the case in India. The unpopular reforms (unpopular among the 'haves') were generally initiated by the central leadership in India. Radical land reforms, minimum needs programme, ceiling on urban property, the new economic programme and many others which were aimed at ameliorating the conditions of the poor, were implemented at the instance of the Central government alone.

Over and above all, no area development plan can be insensitive to what is going on in the country as a whole. The national policies and programmes can be an asset as well as liability for an area. They are, however, important factors influencing it and cannot be ignored while launching an integrated rural area development plan.

### B. Location of Productive Activities

The location of productive activities in a region _vis_-_a_-_vis_ other regions is an important factor of development. Productive activities are of four major types in terms of location choice:

i) input oriented;
ii) market oriented;
iii) intermediate site oriented; and
iv) footloose.

The primary activities like agriculture are well known cases of input oriented activities. They are found only where natural resource inputs like land, water, etc. are available. The secondary activities like manufacturing can be located near the source of the raw material or near the market for finished products or in between source of input and the market for the final product. They can also be footloose i.e., get located at any place. The tertiary activities like transportation, banking, etc. are market oriented.

Except in those unusual cases in which location is either fixed or entirely indeterminate, transfer costs -- the cost of transporting unfinished goods for final processing or finished products to final markets - affect an industry's choice of location. That is the major reason why regions do not maintain a given position in the total scheme of things over long periods of time. Requirements of industries change and hence the advantages and disadvantages of a region are weighed quite differently over time.

## C. Employment and Consumption

In developing countries like ours, where a large percentage of population is either unemployed or underemployed, one of the basic objectives of planned development has to be full employment. Consumption levels of the people are related to the income which depends on employment. Unless there is adequate demand for goods, productive activities cannot be attracted to a region. But all this leads us to nothing but an insoluble problem: which should come first - demand or supply?

The only way to loosen this knot is to work on both the fronts simultaneously. We must aim at providing as

much employment opportunities as feasible so that maximum number of people get some work. This means that we have to be very carefully selective about the technology of production. Mass employment of the people is possible only in small scale sector of industry and in agriculture, both of which are labour intensive. Accent in area development plans has to be on mass employment of people by redistribution of land, diversification of agricultural activities and extensive development of tertiary activities oriented to production, and not on capital intensive activities such as mechanised agriculture, although one can theoretically prove that mechanisation leads to greater employment opportunities.

## D. Nature of Regions/Areas

The fourth factor influencing development of an area is the resource endowment of the area itself. Not every area can hope to have every productive activity because of the comparative advantage one area has over the others in terms of resources, markets, human skills and labour costs, amenities, climate and transport facilities and cost. Some areas can hope to grow mainly by attracting labour-intensive activities; others, by attracting certain kinds of processing industries using relatively unexploited natural resources; some may have special advantages for certain types of assembly operations, agro-industries or services; still others for relatively intensive recreation and tourist activities and so on.

The attraction of industry is clearly a competitive matter. There are many things that an area can do to enhance its location advantages, particularly with regard to facilities, as in improving transportation and

major services such as better education. But many features of nature and position within the nation are unalterable, and so a realistic appraisal of an area's relative advantages and disadvantages with regard to input-output access is an essential starting point for understanding its development potential, as well as its past development.

We can classify regions and areas on the basis of their access characteristics. The classification suggested by Harvey Perloff is given in figure 4.1. If we accept the access characteristics as the index of development potential then Region 4 in figure 4.1 would have little prospect of development, while Region 13 would have unsurpassed development potential. Other regions fall in between these two extremes. The 16 regions are grouped into 5 classes - 0 to IV in ascending order of development potential.

## E. Economic and Social Infrastructure

The effective use of the cumulative advantage to a region depends on the human resources which depend upon the social infrastructure - culture, health, education, social institution, etc. Skillful and well-equipped human beings constitute the foremost pre-requisite of any development. Investment in human resources therefore constitutes the first priority. An intensive effort to improve education, to prepare young persons for a lifetime of skilled, productive work, is the key-stone of any development programme. Compared with other governmental measures that have been proposed, public investment in education promises the greatest relative return. It might include central and state funds specifically provided for the low-income areas with both total expenditure per pupil and the non-local share increasing in inverse ratio to the average level of

| | | Good access to basic inputs from external sources | | Poor access to basic inputs from external sources | |
|---|---|---|---|---|---|
| | | Good access to basic inputs in home region | Poor access to basic inputs in home region | Good access to basic inputs in home region | Poor access to basic inputs in home region |
| Poor access to external markets | Poor access to markets in home region | (1) II | (2) I | (3) I | (4) 0 |
| | Good access to markets in home region | (5) III | (6) II | (7) II | (8) I |
| Good access to external markets | Poor access to markets in home region | (9) III | (10) II | (11) II | (12) I |
| | Good access to markets in home region | (13) IV | (14) III | (15) III | (16) II |

Fig. 4.1 - Types of Regions exhibiting different growth potentials.

income in the area. Such an effort might well focus on th establishment of quite large standard schools, bringing in students over a wide area, staffed by well-paid teachers a providing for better than average general and vocational education. A highly developed system of vocational guidan could be attached to such standard schools. This would also be the best and most effective measure to help wipe out underemployment. Educated skilled persons can be counted on to seek out good employment and income opportun ties and equally important, situations favourable to continued development of individuals. The same applies to health and other social facilities.

F. Political Mobilization and Popular Participation

No amount of natural resources, capital resources, etc. would be of any avail unless the creative energies of the people are pooled together for the developmental tasks and the people willingly participate in their own o community's welfare. It is not uncommonly that we find different groups of people working at cross-purposes and behaving like a motley crowd getting tired of moving around aimlessly.

Commitment to national development and disciplined participation in it are <u>sine qua non</u> for any development. This calls for well-knit political organization and administrative set up which are prepared to carry out developmental tasks by objectives - the objective of greatest good of the greatest number. In a situation where the fruits of development tend to pass on to a micro-scopic minority, popular participation is neither possible nor expected.

One of the major objectives of an area development plan is to evolve a pattern of socio-economic change which would go in favour of the underprivileged groups of people specially in the rural areas.

## G. Psychological Factors

Development, not too infrequently, is triggered off by a sudden boost in the confidence of the people in their own capacity to create 'miracles'. So long as the people feel inhibited and diffident, the prospects of development are not very very bright. The confidence comes through achievements. So long as the planning and development agencies take credit for development themselves, the people cannot gain the confidence needed for rapid and sustained socio-economic development.

It is important, therefore, to evolve a procedure for planned development which would aim at

1. development of the people, by the people and for the people (here people means the poor majority); and

2. achieving something which the people consider to be spectacular.

Once the people get the feeling that even, 'impossible' can be made 'possible' by their own efforts, their further participation in developmental activities could be taken for granted.

## H. Indicators of Development

While planning for regions or areas, we often encounter the problem of measuring the level of development. We need this measure to compare one area with the rest.

Several, very simple to very articulate, methods of measuring development have been devised, but none of them can really be accepted without reservations. Development as we have already seen, has many facets. Inherent in the use of the term is some sense of significant change in the way people produce, consume, work, live and play. To record and measure the vast mosaic of change for the nation and its regions and areas is not simple. It is better part of wisdom to appreciate that existing conceptual and statistical tools can grasp only the crude notion of the nature and direction of these changes.

Development has two major components - welfare of men and volume of growth. Distinction between the two is important because an area may have an increase in one without a corresponding increase in the other.

1. Measuring the growth of economic activities:

Several indicators have been suggested to measure the growth in volume of economic activities of an area/region. Some of these are:

1. Population,
2. Income, and
3. Employment.

Population: Population growth is often considered to be an indicator of economic development. If an area is losing population, most probably it would be because of lack of opportunities. Conversely, if an area is gaining in population, it may also be growing faster economically. Like the air masses, the masses of people also move from high pressure area to low pressure area. The degree of pressure is determined by the Man-Opportunity ratio. As

soon as opportunities improve, a change in the pressure system of the national space (which is open) takes place and flow of people starts. Inflow is an indicator of development (more opportunities) while the outflow is an indicator of sliding back of the economy in absolute or relative terms.

One must, however, note that the cases of increasing population and stagnant economy are not infrequently encountered. This is specially the case in areas of poverty-striken people who have a very high reproduction rate and who are not so mobile because of their social condition. There are also cases of people from highly developed areas moving out to elsewhere for better opportunities, especially to areas where they face less of competition.

Personal income: A comprehensive and suggestive measure of regional economic development is provided by total personal income and per capita income. Higher the income, more developed an area. It must, however, be kept in view that total regional income or personal income or per capita income may not give the real income situation. Distribution of income may be so skewed that only a small minority may get the major share.

The following table explains the concept of income.

GNP (Gross National Product)

Less: Capital consumption allowance
Equals: NNP (Net national product)
+ Subsidies minus current surplus of Govt. enterprises
Less: Indirect business tax and net tax liability
Business transfer payment

<u>Equals</u>: <u>National Income</u>.

<u>Less</u>: Undistributed corporate profits
Corporate profits tax liability
Corporate inventory valuation judgment.
Contributions for social insurance
Excess of wage accruals over disbursement.

<u>Plus</u> Net interest paid by government
Government transfer payments
Business transfer payments.

<u>Equals</u>: <u>Personal income</u>

<u>Less</u>: Non-corporate depletion charges
Net imputed rent of owner occupied dwellings
Changes in farm inventories not held for sale
Employer contribution to private pension and welfare fund
Income in kind to armed forces
Government military life insurance benefits
Business transfer payments
Inventory valuation adjustment (non corporate).

<u>Plus</u>: Premiums to military life insurance funds
Private pension payments.

<u>Equals</u>: <u>Income payment to individuals including</u>
Wages and salaries
Proprietors' income
Property income, and
Other income

Regional income may be obtained by adding either the factor incomes paid out by sectors of the economy or factor payments received by all sectors. The totals should be identical.

Employment: Per cent of the working population actually employed is another indicator of development. More the un-or under-employment, the less developed an economy is. There are, however, several problems in measuring employment and under-employment. No correct estimates of unemployed is available either. The data received from employment exchanges are not very reliable for the obvious reason that many unemployed never get themselves registered and also because many who are employed but not satisfied with the job they hold, also keep their names in the register.

There is close relationship between industrial structure, employment and income levels. Areas which are predominantly agricultural have lower income and employment opportunities.

2. Measuring the Welfare:

Economic growth is not a real indicator of development. It has been often seen that in developing societies marked with wide disparities in socio-economic levels of the people, economic development has led to increased poverty of the masses. The new income generated is usurped by a small minority; its power of exploitation further improves and the welfare of the common man in real terms decreases as total income of the area increases. It is therefore erroneous to treat the average per capita income as the real indicator of welfare.

The welfare of the people depends on that income which is not used for luxuries and unproductive purposes plus the amenities and services available to them free of cost. It is very closely tied to a set of specific goals which a representative government and a forward looking

planning institutions attempt to achieve. These may include:

1. A minimum acceptable diet for each individual;

2. Minimum housing standard;

3. At least twelve years of schooling of a given standard;

4. Minimum medical hospital services, minimum access to recreational and cultural facilities;

5. A minimum standard of security ensured by the law and order maintenance agencies;

6. A minimum of social defence and social security;

7. Adequate income to maintain a minimum standard of living;

8. Equality in employment opportunities and choice of employment;

9. Social justice curbing luxurious living and slum living; and

10. Freedom of speech, work, worship, movement, etc. within the limits set by the people themselves.

Many other points can be added to this list. It is now clear that meaning of the term 'welfare' is more difficult to translate in quantitative terms than 'Income'. Attempts have been made by several national and international agencies to evolve indices of welfare, but nothing has so far emerged which is acceptable universally.

In a subsequent chapter of this volume, we would revert to this aspect again. Here suffice to say that, as growth cannot be equated with development, 'income' cannot be equated with 'welfare'.

Chapter V

## WATERSHEDS AS UNITS OF PLANNING*

Stream watersheds form a convenient areal unit of planning because they can be simply and unambiguously defined from a topographic map. They are independent of scale in that large river basins like the Cauvery can be broken into a hierarchic system of smaller basins; each smaller basin fits exactly within the next larger one.

The hierarchy of stream segments can be ordered in several different ways to designate the order of the watershed. Strahler's system designates the fingertip tributaries as order 1. The channels formed by the junction of two first order channels are designated as order 2 and the channels formed by the junction of two second order channels are designated order 3, and so on. (See fig. 5.1)

Watershed is an area which drains into a river. Thus there is a hierarchy of watersheds as there is a hierarchy of rivers. The smallest watershed is formed by the fingertip tributaries. In figure 5.1 the largest watershed is formed by the third level tributary within which the second and first level watersheds fit. There would be as many watersheds of a particular hierarchic level as the number of tributaries of that level. For example, in figure 5.2 there are 3 streams of first order and 1 stream of second order. There are therefore 3 watersheds (I, II and III) of first order and one watershed of the second order.

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* Partly drawn from Peter Haggett: Geography: A Modern Synthesis.

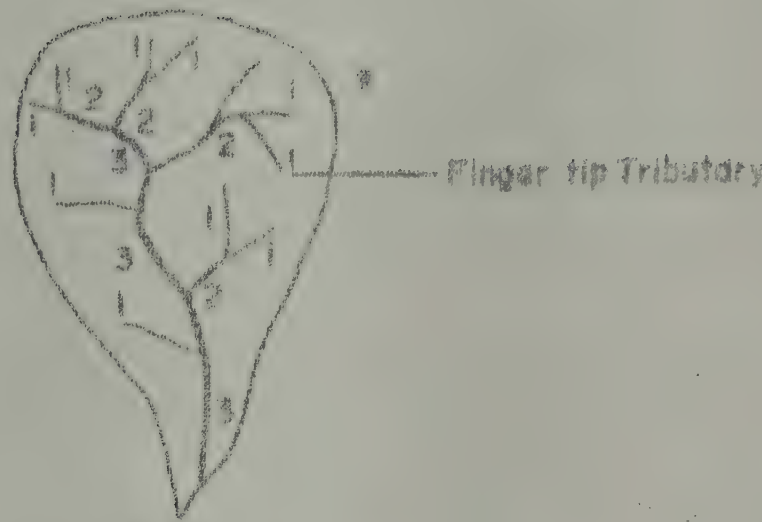


Fig 9.1

Fig. 9.2

Watersheds as units of planning have several advantages. Edaphic changes in soil and vegetation reflect location within the watershed as the physical features of a basin directly affect the hydrologic characteristics of the streams draining it. A rainstorm falling on a long, narrow basin is likely to produce a lower discharge in the stream draining it than a similar storm falling on a rather broad, almost circular basin. Watersheds therefore form the appropriate units for intervention in flood control, navigation, hydroelectric power production, soil conservation, water management, crop planning, etc. It constitutes an ideal areal ecosystem for planned development of natural resources.

Watersheds in humid areas:

Humid areas with profuse rainfall often suffer from recurrent floods in flat lands and soil erosion in the steeply sloping lands. In its natural state, a watershed offers a complete ecosystematic balance between topography, rainfall, vegetation and animal life. Because of the vegetative cover of the area, the rain water moves down the stream only slowly. Considerable amount of it is absorbed as soil moisture and percolates underground.

Man's intervention by way of agricultural use of the land and exploitation of vegetation for commercial purposes, often renders the ecosystem unbalanced. It has to be remembered that watershed also constitutes a spatial ecosystem in which the smallest watershed is organically linked to larger watersheds. Any disturbance in a small watershed would have repercussions in the larger area. The *vice versa* would also be equally true. If the watershed resources are used without keeping this ecosystematic

integration in view, the system is rendered unbalanced and several negative forces do not allow the rebuilding of the resources like soils, vegetation, etc.

In the humid areas, the felling of the forests and indiscriminate use of land for various purposes can lead to the following major problems:

1. Floods;
2. Soil erosion and soil depletion;
3. Irregularity in rainfall; and
4. Lower carrying capacity of land.

Watersheds in semi-arid areas:

In areas with scanty rainfall, watersheds are important controlling factors. In such areas, the rains come seasonally and in large quantity. In the absence of any vegetation on the slopes, the water carries the upper mantle of the soil down stream leading to intense sheet and gully erosion. A side effect of this is the unpredictable and sudden flooding of the lower stretches of the stream and lack of soil moisture. The second problem is more serious in undulating topographic areas like that in peninsular India. In the desert areas, the flooding of the usually undefined streams and removal or burial of good soil by sand constitute a serious problem.

The scanty vegetation found on the slopes of these watersheds are often used up by domestic animals. The bigger trees fall prey to human ignorance, and soon the slopes are left without grasses even. In due course, the capacity of land to sustain human activities declines and poverty and pestilences result. One of the most important

objectives of watershed planning in these areas is to bring back the ecological balance through scientific use of the land so that soil erosion is minimised, rainfall is more regular, rain water percolates in the soil and the carrying capacity of the land increases.

Identification of watersheds for micro-planning:

As noted earlier, watersheds can be of different sizes depending upon the order of the stream we select for the purpose. Thus the Cauvery basin forms one watershed. Within the Cauvery basin, we have Kabini watershed, and still smaller ones. The question is: which size of the watershed should be used in integrated rural area planning?

The optimum size of a micro-watershed largely depends on the specific emphasis of the development programme. If the programme aims at integrated area development, as is the case with DPAP, the emphasis is clearly on optimal utilization and conservation of land and water resources. Water being the most precious element in drought prone areas, the desired watershed function of the land is primarily to receive precipitation and to utilise it in the most efficient way. Even in areas of deficient rainfall, watersheds convert large amounts of rainfall to stream flow. For example, in places where the rainfall is only 60 cms. annually (and this is the situation over larger part of the drought prone areas in India), a plot only 10 feet square receives and disposes of about 6.25 tons of water each year. One acre receives 2,718 tons; and 10,000 acres, not a very large watershed, receives and disposes of more than 27,180,000 tons.

The concentration and time distribution of run-off from a watershed is mainly governed by the size and shape of the watershed. Surface run-off in some watersheds is quickly assembled and discharged. In some others, the surface drainage is delayed longer and the discharge released more slowly. Part of this influence is due to soil characteristics and part due to vegatative cover. As watersheds increase in size, they become more complex with regard to slope, topography, soil and the vegetative cover conditions.

Watershed management is thus primarily concerned with planning the land use to suit the landscape. Land use planning, in turn, is closely linked with the farming activity. As it has already been discussed earlier, the basic unit for a micro-region or rural area for planning should be a farming locality with a radius of no more than 5 kms.

The optimum size of a micro-watershed for integrated rural development should, therefore, be no more than 10,000 hectares. A size between 5,000 and 10,000 hectares would possibly be the optimum size. The actual size of the micro-watershed should, however, be determined in accordance with the topographic characteristics of soil texture and composition, vegetative cover and the existing land use.

There are several practical reasons for limiting the watershed areas to 10,000 hectares. In the first place, funds available for micro-level planning are limited, and hence can be better utilized if the investments are made in a small area to restore the ecological balance. If they are spread over too large an area, nothing substantial could perhaps be achieved to make any major impact on the

existing situation. Secondly, the projects identified for implementation at the micro-level are small. And thirdly, the administrative and technical infrastructure available at the micro-level cannot undertake large projects.

As the ultimate purpose of watershed management is to improve the quality of human life in the area, the size of human population should also be taken into account while determining the optimum size of a micro-watershed. The methodology of determining a planning unit and grouping settlements/villages into micro units has already been discussed earlier. It will be seen that a grouping of 5 villages with 200 farming families each will form an optimum micro-unit for development purposes. In administrative terms, a micro-watershed could conform to the size of a village group panchayat.

To sum up, an area of 5,000 - 10,000 hectares and a population of 5,000 - 10,000 persons (or 1,000 - 2,000 households) would make an optimum micro-watershed for integrated rural development. In areas of high population density, the higher population limit and in areas of sparse population, the higher area limit should be the deciding criteria.

## Watershed planning:

After a watershed has been identified, the next step is to prepare a land use plan for the area using the principles explained in later chapters of this volume. It is important to note that agricultural use of the land is not necessarily the best use of it. For a good landuse plan, we should have the following maps:

1. Contour map with contour intervals of at least 5 metres. In case, such a map is not available, as is usually the case, a map with 50 feet interval can be used. It may be recalled that one inch to a mile topographic sheets of Survey of India give this contour interval.

2. A map showing the existing land use should also be prepared. This map should show the land under forests, pastures, field crops, other crops like plantation, fruits etc.

3. A map showing the soil types.

4. A map showing all streams within the watershed, all tanks, all canals and their distributaries, etc.

5. A map showing the areas irrigated by various irrigation methods - wells, canals, tanks, etc.

6. A map showing all human settlements - rural and urban - with important economic and social facilities such as health centre, schools, veterinary hospital, drinking water facilities, communication facilities like post and telegraph offices and other public institutions like co-operative, banks, police stations, etc, and

7. A map showing the road network with bus facilities.

[illegible] 1, 4 and 5 are given in [illegible].

As discussed in chapter IX the land of the area should be classified into eight categories and each category should be assigned a particular type of land-use. But, if detailed data pertaining to soils are not

available, a slope map should be prepared using the contour map as a base. Distance between two contour lines in kilometres, and the difference between contour values should form the basic data to prepare a slope map. For example, if the distance between two contours along a given line is 20 kilometres and the contour value difference is 300 metres, then the slope is 15 metres per kilometre or 1.5 per cent.

To facilitate this work, the whole area may be divided into squares of 1 kilometre and then each square may be assigned the slope so calculated. When the whole area is marked with squares of different slopes, we can use the principles discussed in chapter IX to assign land for various purposes.

The funds available for various sectors such as agriculture, forestry, animal husbandry, etc. should be used within the framework of the landuse plan prepared for the watershed. Within the constraints of this plan should also be developed animal husbandry and other activities such as industries. The settlement, road network and other maps can be fruitfully used to locate and create facilities which would strengthen the economy of the watershed. For example, if there is enough land for pasture development, the scope of dairy industry could be studied. But this industry would need marketing facilities, suitable road-network, veterinary hospitals, artificial insemination centres, feed manufacturing or mixing centres, finances, etc. All these have to be planned in advance before launching the dairy development project.

The same applies to other development activities including crop farming. The supply of modern inputs and

the facilities for evacuation of the products through market channels has to be assured. The educational and health problems of the people have to be attended to.

All this means that watershed planning is not only a device to conserve the land and water resources and to make the best use of them but also to carry out an integrated physical and socio-economic development planning exercise within an ecological framework.

Chapter VI

# THEORIES AND MODELS USEFUL IN INTEGRATED AREA DEVELOPMENT PLANNING*

After having discussed some of the basic principles and concepts underlying integrated rural area development, let us now proceed to examine some of the relevant theories and models useful to us. These are examined here, with two objectives in view. First, every planner should have some idea of these theories and models for they are generally referred to in planning and development literature; and second, every planner must attempt to evolve new models by modifying or adapting the existing ones to suit his specific planning situation.

## A. Economic Growth Models

Theoretical models of regional growth (development) are essentially by-products of general economic theory and therefore cover only certain aspects of regional development process.

### 1. Myrdal model:

Gunnar Myrdal, a Swedish economist, has stressed that economic market forces tend to increase, rather than decrease, regional differentiation. In his model the build up of activities in prosperous growing regions influences the less prosperous regions through two types of induced effects

1. Spread effects and
2. Backwash effects.

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* Partly drawn from Isard, Methods of Regional Analysis, Cambridge, MIT, 1968 and from Peter Hagett: Geography: A Modern Synthesis.

The first refers to the positive impact on all other regions of growth in the thriving region. This growth comes from the stimulation of increased demand for raw materials and agricultural products and the diffusion of advanced technology. The second refers to adverse effects of agglomerated (concentrated) growth leading to net movement of population, capital and goods in favour of the growing area. The classic backwash effect works through selective migration, which has harmful effects on both the age and skill structure of the sending region.

The two opposing forces do not imply the existence of an equilibrium situation. Indeed, Myrdal maintains that the balance of the two effects occurs only rarely. A more likely situation is a cumulative upward or downward movement over a considerable time that leads to long periods of increasing regional contrasts. This situation as applied to a growing region called cumulative upward causation is given in the fig. 6.1. The reverse is true for lagging regions.

Myrdal model is qualitative. There are some more precise econometric models, a summary of which is given below.

2. <u>Neo-classical models</u>:

These models of growth are supply oriented, i.e., if the supply of inputs are assured, growth will also be assured. The rate of growth in income is determined by three elements: capital accumulation, an increase in labour supply and technical progress. The latter is assumed to be a constant function of time. For the sake of brevity, let us put this in following form:

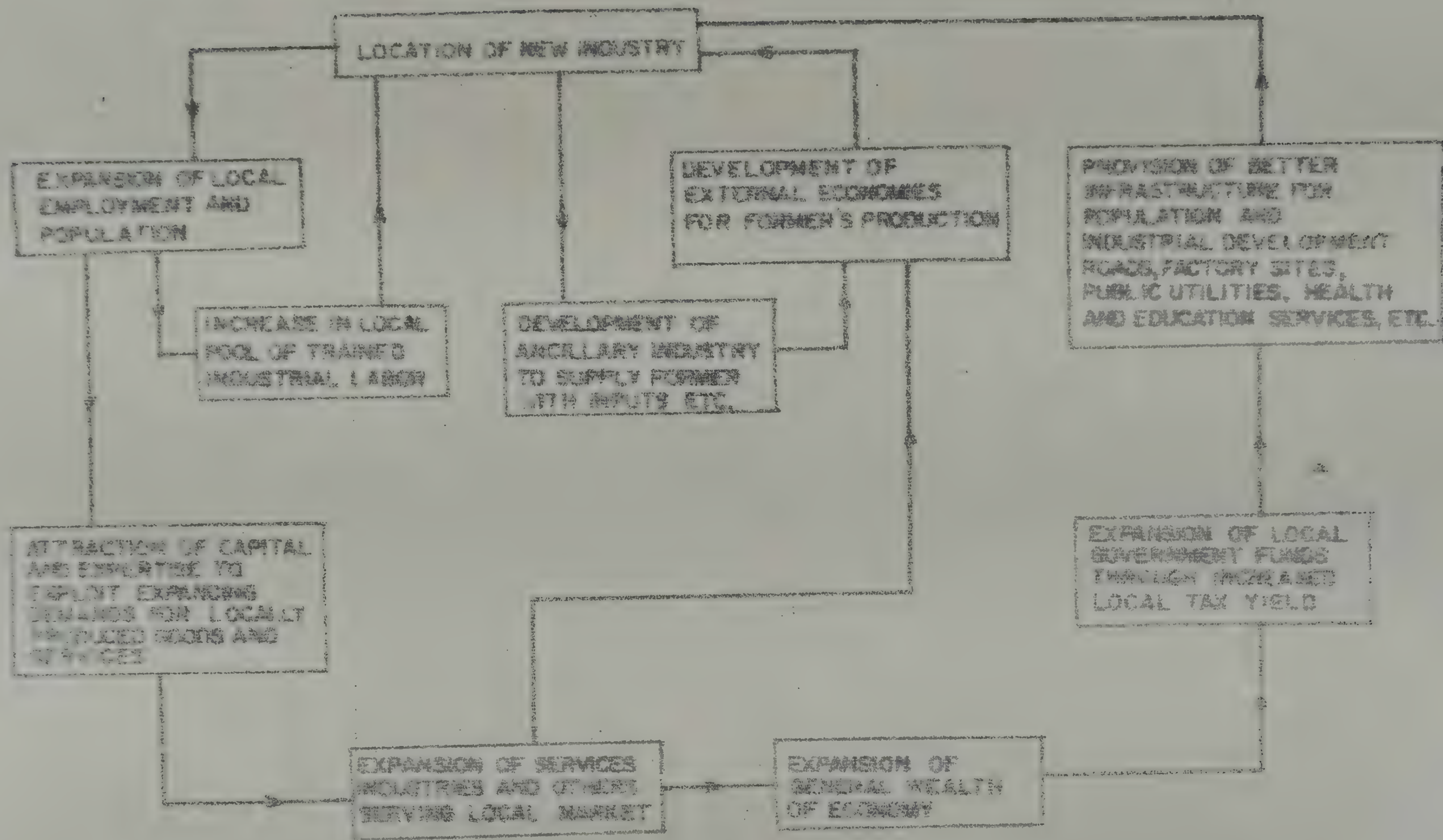

LOCATION OF NEW INDUSTRY
EXPANSION OF LOCAL EMPLOYMENT AND POPULATION
INCREASE IN LOCAL POOL OF TRAINED INDUSTRIAL LABOR
DEVELOPMENT OF ANCILLARY INDUSTRY TO SUPPLY FORMER WITH INPUTS ETC.
DEVELOPMENT OF EXTERNAL ECONOMIES FOR FORMER'S PRODUCTION
PROVISION OF BETTER INFRASTRUCTURE FOR POPULATION AND INDUSTRIAL DEVELOPMENT ROADS, FACTORY SITES, PUBLIC UTILITIES, HEALTH AND EDUCATION SERVICES, ETC.
ATTRACTION OF CAPITAL AND EXPERTISE TO EXPLOIT EXPANDING DEMANDS FOR LOCALLY PRODUCED GOODS AND SERVICES
EXPANSION OF SERVICES INDUSTRIES AND OTHERS SERVING LOCAL MARKET
EXPANSION OF GENERAL WEALTH OF ECONOMY
EXPANSION OF LOCAL GOVERNMENT FUNDS THROUGH INCREASED LOCAL TAX YIELD

Fig.6.1

$$Yi = Fi\ (K, L, t)$$

where Y = real regional income; K = capital stock; i = region, L = supply of labour and t = time subsuming technological progress.* The model requires that there is continuous full employment of the capital stock, a demand that calls for some mechanism to equate investment with full employment and savings. In the neo-classical theory, this mechanism is none other than rate of interest (r). The model also prescribes that output and capital accumulation must expand at the same rate. Ultimately, it is the capital output ratio that determines growth.

From the above, we can derive another equation which is indicative of the rate of growth:

$$Yi = a_i k_i + (1 - a_i)\ ni + Ti$$

where Yi = rate of growth of output or income, k and n the rates of growth of capital and labour respectively, T the rate of technical progress (i.e., the annual rate of growth of output due to technical progress alone), a = capital's income share (marginal product of capital, $\Delta Y/\Delta K$, multiplied by K/Y), and lucause of constant returns (1 - a) = labour's income share ($\Delta Y/\Delta L$ multiplied by L/Y), all referring **to region i.**

3. Harrod-Domar Model:

Unlike the neo-classical equilibrium growth model, the Harrod-Domar model is demand oriented, i.e., the backwardness is because of the lack of effective demand rather than because of shortages of factors of production. The available resources such as labour are not fully utilized and hence the demand for goods is lagging and hence low

* Fi denotes that Yi is a function of k, l and t with unspecified relationship.

production and hence underdevelopment. This model differs from the neo-classical model in another sense. It postulates cyclical growth as against steady growth.

The equilibrium growth (i.e., adjustment of growth rates of various regions to a common growth rate) requires labour to migrate from low income to high income regions and capital to flow in the reverse direction. While the first could happen, the flow of capital from high income to low income region is doubtful. The regions with higher propensities to save and lower capital-output ratio should grow rather rapidly. Thus regions with net import surpluses ($m_i - (X_i/Y_i) > 0$, where $m_i$ = marginal propensity to import in region i, $X_i$ = export of region i, $Y_i$ = output of region i) should grow faster than other regions. Similarly, regions experiencing net immigration should tend to growth faster than regions affected by net emigration.

4. <u>Export based theory of growth</u>:

According to this theory, the growth of a region depends upon the growth of its export industries implying that expansion of demand external to the region is the crucial initiating determinant of growth of the region. Thus, an increase in the export base, a concept denoting collectively all the exportable goods and services of a region, set off a multiplier process (where the multiplier is equal to total regional output divided by total export). The presumption is that all economic activities are not for export , especially the region's trade and service activities. Nevertheless they are induced by the expansion or decline of export industries. This theory thus emphasises the earlier explained view that the growth of a region is not likely to be decided within its own borders.

The limitations of this theory are quite obvious. is too simplistic; it is non-predictive and insensitive to the realities of a multi-commodity, inter-regional economy. Expansion in different components of the export base could have widely diverse results for regional growth. Secondly, the theory ignores the fact that internal growth impulses may be vital factors in regional growth. This is more so in the case of a macro-region.

5. Other models:

There are a few other hypotheses which contain the seeds of a theory or model. We propose to list them below, for they do not appear to be of much significance for our present discussion. Sector theory proposed by Clark Fisher suggests that rise in the per capita income would be accompanied by a decline in the proportion of resources employed in agriculture and a rise in manufacturing (secondary) and later in service (tertiary) industries. Perloff, Dunn, Lampard and Muth contend that the growth of region is more likely to be determined by the structure of the industrial economy rather than by income. A region may grow because it has industries which are growing fast nationally or because it is gaining an increasing proportion of a given industry or industries, regardless of whether these industries are growing or not.

6. Comparison and Review:

We can now compare the major theories and models of regional growth.

Characteristics of Fast Growing Regions

| Economic model | Income level | Direction of labour flows | Direction of capital flows | Direction of inter-regional growth |
|---|---|---|---|---|
| Model 1 (Neo-classical) | Low | Outward | Inward | Convergence |
| Model 2 (Harrod-Domar) | High | Inward | Inward | Divergence |
| Model 3 (Export Base) | Unspecified | Inward | Outward | Unspecified |

The above models are not so very relevant to integrated rural area development. Yet one can easily get some insights from them. In the first place, it is clear that diversification of activities with accent on those products which have markets outside is important for rural development. Secondly, it is also important that the consumption pattern of the people must change, which is possible only if their income increases and is better distributed.

Along with these models which were not constructed in the light of the problems of the developing countries and regions, we must keep in view the indigenous models suggested by Mahatma Gandhi and social development model, which de-emphasise the pre-eminent role of income as a measure of welfare. Since these models are either too well known to us or are to be discussed in later pages of this volume, we can ignore them here.

## B. Theories of Spatial Development

Having discussed some of the models of economic growth, we now proceed to discuss the theories which are pertinent to the spatial (horizontal) arrangement and location of various human activities including population centres. Knowledge of these theories helps us in taking a more rational decision with regard to location of various production and consumption oriented activities.

### 1. Von Thunen's Isolated State:

Perhaps the earliest attempt to explain the land use in relation to a central place (village or town) was made by Von Thunen in his book De Isolierte Slaat in Bezlehung and Landwirtschaft first published in 1826. In 1810 Thunen, at the age of 27 acquired an agricultural estate, Tellow, near the town of Rostock in Meeklenburg on the Baltic coast of Germany, and accumulated data during the subsequent 40 years which provided the basis for his theory.

Thunen postulated a concentric pattern of landuse with a number of bands ranging from narrow bands of intensive farming zone and forest zone to a broad band of extensive agricultural zone and ranching zone to the waste that lies beyond. His model is given in fig.6.2.

Thunen's model was an idealized form of land use pattern valid only under following conditions.

1. The existence of an isolated state cut off from the rest of the world.
2. The domination of this state by a single large city that served as the sole urban market.

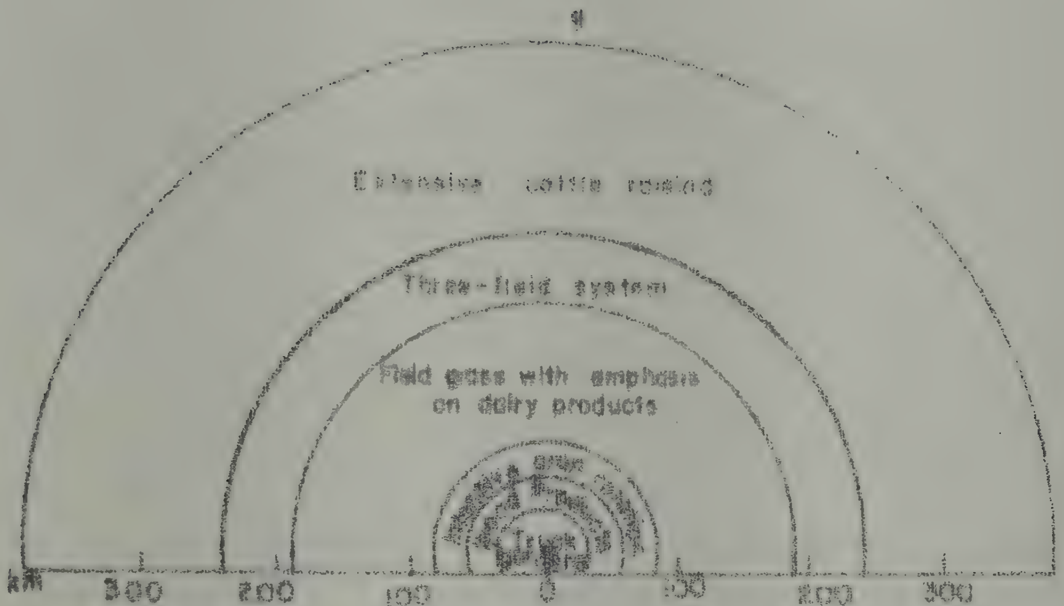

Extensive cattle raising
Three-field system
Field grass with emphasis
on dairy products
km
300
200
100
0
100
200
300

Fig.8.2

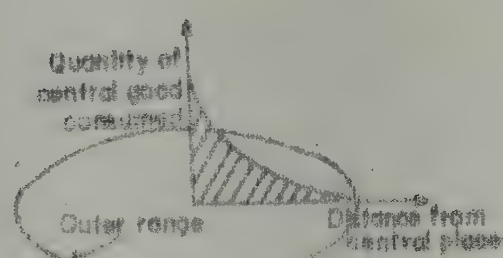

Quantity of
central good
consumed
Outer range
Distance from
central place

Fig.8.3

3. The setting of the city in a broad, featureless plain that was everywhere equal in fertility and ease of movement so that production and transport costs were everywhere the same.

4. The suppliers of the city are farmers who shipped agricultural goods there in return for industrial produce.

5. Transport of farm produce by the farmer himself, who hauled his own produce to the central market along a close, dense trail of converging roads of equal standard with costs directly proportional to distance.

6. Maximising of profits by farmers in terms of automatic adjustment of crops to the needs of the central market.

The above assumptions were made by Thunen to simplify the problem and to provide a model. If we relax the assumptions, the shape of the rings would change in the same way as a circle drawn on a rubber sheet would change its shapes depending on the force with and directions from which it is pulled.

Thunen regarded the operation of locational rent as the key factor in sorting the uniform . area of his isolated state into distinct landuse zones. Locational rent for any crop at any location is given by:

$$L = Y(P-C) - YD\ (F)$$

where, $L$ = Locational rent (Rs/Km$^2$)

$Y$ = Yield of crop (tons/Km$^2$)

$P$ = Market price of the crop (Rs/ton)

$C$ = Production cost of the crop (Rs/ton)

$D$ = Distance to the central market (Km.)

$F$ = Transport rate (Rs./ton/Km.)

Thus for a crop yielding 1000 tons/$km^2$ fetching Rs.100/ton at the central market, costing Rs.50/ton to produce, and Rs.1/ton/km to haul, the locational rent at the city centre would be Rs.50,000/$km^2$, at 10 km. distance only Rs.40,000/$km^2$ and at 20 km. distance down to Rs.30,000/$km^2$. Beyond 50 km. production would be at a loss. The competition of two crops (i and j) for the same area depends on their yield (Y) and relative profitability (P-C). When the condition:

$$1 < \frac{Y\ (P-C)\ i}{Y\ (P-C)\ j} < \frac{Yi}{Yj}$$

obtains for crops i and j, they form two distinct spatial zones; crop i dominates a circular area adjacent to the city, and crop j occupies a ring-shaped zone immediately outside it. Symbol $<$ means 'less than'.

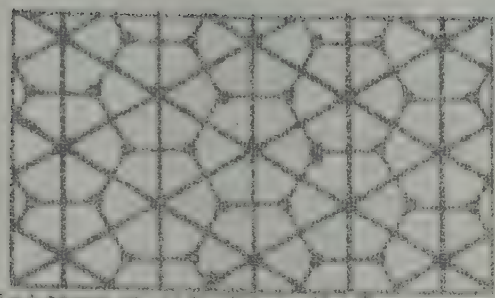
2. <u>Central place theory of Walter Christaller</u>:

Christaller (1893-1969), a German scholar, wrote a dissertation on the settlement structure of Southern Germany in 1932. Partly because of his association with Nazis and partly because of the language barrier, the concept evolved by him did not catch the attention of scholars until late 1940s.

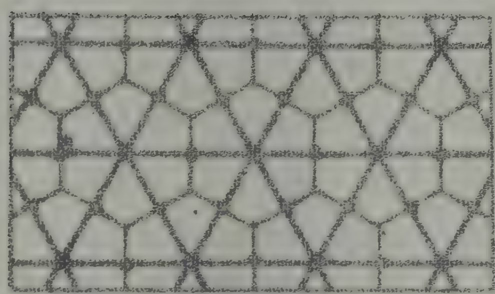
The terminology of Christaller's model is straight forward. Central places are broadly synonymous with towns that serve as the centres for regional communities by providing them with central goods and central services. Central places vary in importance. Higher order centres stock a wide array of goods and services; lower order centres stock a smaller range of goods and services, that is,

some limited part of the range offered by the higher centre. Complementary regions describe the areas served by each central place. They exist for both higher and lower order centres and are defined by town-country relationships. The regions for higher order goods are large and those for lower order goods are small.

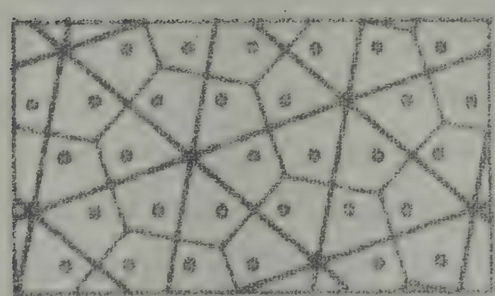
Christaller defined the centrality of an urban centre as the ratio between the services provided and the local needs of its inhabitants. Towns with high centrality would supply many services per inhabitants and *vice versa*. In recent years, two more terms have been added to Christaller's theory. Threshold refers to the minimum size of market below which a place will be unable to supply a market good. That is, below the threshold's lower limit sales will be too small for firms to earn acceptable profits. Range of Central good delineates the market area of a central place for the good. The market area's lower limit is determined by the threshold limit, and its upper limit is defined by the distance beyond which the central place no longer is able to sell the goods. If we assume that travel is equally easy in all directions, the range of a good will be a perfect circle which is the outer limit of a demand cone in which the quantity of a central good consumed decreases with distance from the central place because of increased transport cost (Fig.6.3, p.93)



(a) Market optimizing K = 3



(b) Traffic optimizing K = 4



(c) Administration optimizing K = 7

- Central place
- Dependent place

—— Boundary of complementary region
—— Highways between central places

Fig.6.4

Given the circular demand cone, Christaller demonstrated that the final solution for a group of central places of similar order is a set of hexagonal complementary regions where the central places are arranged in a regular isometric lattice. The circle was replaced by hexagon because the latter when arranged together, does not leave any space uncovered. He suggested three organisations of central places to optimize marketing, transportation and administration. In all the three cases Christaller assumed that the relationships established for one level (e.g., between village and small town) will also apply to other levels (e.g., between city and metropolis); he called it fixed K-hierarchies. For the three cases, the K values would be 3, 4 and 7 respectively. This means that in the first case, each higher level centre will serve three next level centre including itself; in the second case, each higher level centre would serve four next level centre including itself, and so on. The pattern of location of centres would be as given in fig. 6.4.

Christaller model takes into account only the tertiary activities, i.e. commerce, trade, transport, administration and services. It is an useful theory for optimal location of these activities. Losch, a fellow German, used the hexagonal frame of Christaller and brought the secondary activities (manufacturing) also into the model. In his scheme, settlements of the same size need not have the same function, and larger places need not have all the functions of the smaller central places.

3. Growth Centre theory:

Francis Perroux, a French regional economist, developed the concept of growth pole which in essence

means that to develop a lagging region, one should concentrate on a number of expanding industries usually within a major city to set off a chain reaction of minor expansions throughout the hinterland. Thus a growth pole policy in regional development is the deliberate selection of one or a few potential poles within a problem area. New investment is concentrated in these poles, rather than being spread thinly over the whole area. The arguments in favour of this policy are that public expenditure is more effective when concentrated in a few clearly defined areas and that the new industries there will stand a better chance of building up enough external economies to achieve some degree of self-generating growth.

In practice the growth pole policy faces three problems: a technical one of selecting the best potential pole; a political one of convincing the unsuccessful candidates of the wisdom of the policy; and a stragetic one of making a choice between centralized and decentralized development. This theory suffers from urban and industrial fundamentalism and does not appear to be so useful in areas which are essentially rural. In such areas Christaller becomes more relevant.

To get over these problems associated with the growth pole theory and make the concept applicable to Indian rural condition, Misra and Sundaram evolved the concept of system of growth foci. In this model, the growth foci consist of a hierarchy of central places. Higher the level of a centre in the hierarchy, more the activities of secondary and tertiary type. Lower the level, more agro-based the activities. They have suggested a five tier hierarchy:

1. Growth pole
2. Growth centre
3. Growth point
4. Service centre
5. Central village

The size and spatial distribution of these would be determined by the level of socio-economic development of the area/region.

## C. Stages of Development

Several social scientists have postulated the characteristic changes which take place in economic system as development proceeds. The changes are such that differe stages of development could be noted. The proof for these is provided by economic and social history, more important the former. A summary of these postulations is given below:

| | Author | Stages |
|---|---|---|
| 1. | Hildebrand | Barter - money ---- credit |
| 2. | List | Savage ---- pastoral ---- agri-cultural ---- agricultural and manufacturing ---- agricultural - manufacturing and commercial. |
| 3. | W.W. Rostow | The traditional society ---- the pre-conditions for take-off ---- take off ---- the drive to maturity - the age of high mass consumption. |

The first two are now fairly old and descriptive. They cannot be said to be models. Rostow model is the one which is most debated. It has been criticised on many counts but the most important criticism points to the lack of empirical evidence and regularity. In fact, many developing countries have reached the stage of take off in some sectors but still remain traditional in others. Further, the stages through which western countries passed in their road to economic development in a given historical context, may not be so relevant to the developing countries

of mid 1970s. It is not only possible but also feasible for a developing country to leap-frog some stages by taking the benefit of modern divisible technology.

Notwithstanding the criticism of the model, its terminology is repeatedly used in the developing countries.

## D. Social Models

According to Johnson, the main elements in the structure of a social system are:

1. Sub-groups of various kinds, normatively related.

2. Roles within the larger system and within sub-groups - each role system being normatively related with each of the others.

3. Regulative norms governing sub-groups and roles; and

4. Cultural values.

Every social system must solve four functional problems.

1. Pattern maintenance and tension management;
2. Adaption;
3. Goal attainment; and
4. Integration.

In very broad terms, the family, schools, religious groups and so on deal with the first problem, the economy deals with the adaptive sub-system of society, the polity or government deals with the society's goals and the integrative sub-system is maintained by the legal profession, opinion formers of the mass media, religious leaders and so on. Each of these functional sub-systems of a society can, in themselves, be analysed as a social system and the other systems are then seen as part of the 'environment' to which the sub-group must adapt if it is to survive and achieve

its goals. It, however, so happens that the cost of meeting societal problems is borne unequally by the sub-groups of the society. The major burden falls on those who are the least protected. To understand the social system, we must therefore analyse and study the various sub-groups, the mechanism through which inequalities develop among them, and the planning implications of these inequalities.

The analogue model of social systems suggested by Misra explains the social structural problems in the context of development planning. This model divides human societies into three main types. These are:

1. Porous,
2. Permeable, and
3. Impermeable.

Porous societies are those ideal types whose members are equal in social, economic and other status and which possess mechanism for quick percolatory, capillary and lateral spread of new energy in the whole system. Permeable ones are those which have developed well defined channels for energy movement from one direction to another, leaving a sizeable part of the society unaffected or affected only marginally. The impervious societies are those which do not permit the energy to pass down the various strata; it is absorbed by the upper crust and radiated in the form of conspicuous consumption, etc. Further details of this concept are given in chapter X.

The above terminology is more expressive of the social processes than the usual terms like feudal, semi-feudal, etc.

The main objective of social development is to move the society towards porocity. The present day Indian society is pervious (or semi-feudal). It is controlled by a small group of people who constitute the upper and upper middle strata of society through a series of networks of middle men down to the lowest stratum.

Chapter VII

# METHODS AND TECHNIQUES USEFUL IN INTEGRATED AREA DEVELOPMENT PLANNING - I

This chapter aims at illustrating some of the methods and techniques of data analysis which are often used by area development planners. No attempt is made to cover all possible methods and techniques. Only the ones used more frequently have been selected.

## A. Population Analysis

It is now a well recognised fact that 'people' constitute the most powerful resource of a country. A country with large reserve of quality people can transform the potentials and resources into realities. At the same time, a country with a huge population of illiterates, unhealthy and poverty-stricken people, can do precious little with its known resources.

Developing countries the world over are attempting hard to control their population for they know that poor quality people eat more than they produce. Since the growth of their economy is almost equally matched by the growth of population, they fail to invest enough in activities which can improve the quality of people.

A planner must know the quantity and quality of the people at the time of plan formulation; he should also know the expected growth of population in years to come because planning is done more for the future than for the present. The planner must know the human resources, to identify the activities which can use the available talent and which can fill the gaps in training and expertise.

He has another reason to know the facts. He must estimate the amount and type of food, clothing and shelter he must plan ahead, so that the people are better fed, better cla and better sheltered.

The total population of any country or area represents a balance between two sets of forces - natural change (birth - death) and migration change (immigrants - emigrants). - fig. 7.1.

1. <u>Population forecasts</u>:

Birth and death rates together with migration can provide us data for forecasting future population. There are some limitations of these data but we can ignore these as they are of no major consequence to rural areas. If we subtract the crude death rate from the crude birth rate, we have a rough measure of the rate of natural increase (or decrease) in a population. We should remember here that the rate is calculated per 1000 population. Supposing the difference between the two = 8. It means that we add 8 new individuals every year to 1000 living; i.e., it would take 125 years to double that population (125 x 8 = 1000). But this calculation ignores the fact that the people added to the population would also increase at the rate of 8 per thousand. This means that population growth follows an exponential form just like that of money earning compound interest in a bank. The doubling time is therefore shortened from 125 to only 87 years. The mathematical expression for the exponential rate of growth is:

$$\frac{dN}{dt} = rN$$

where, N = number of people;

r = rate of natural increase (a constant) and

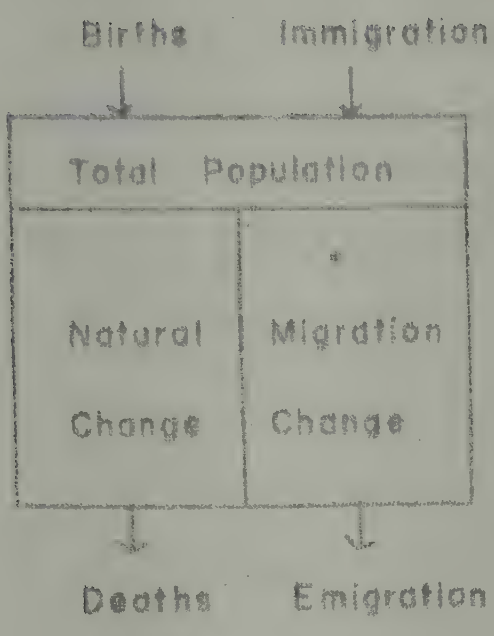

Births
Immigration
Total Population
Natural Change
Migration Change
Deaths
Emigration

Fig.7.1

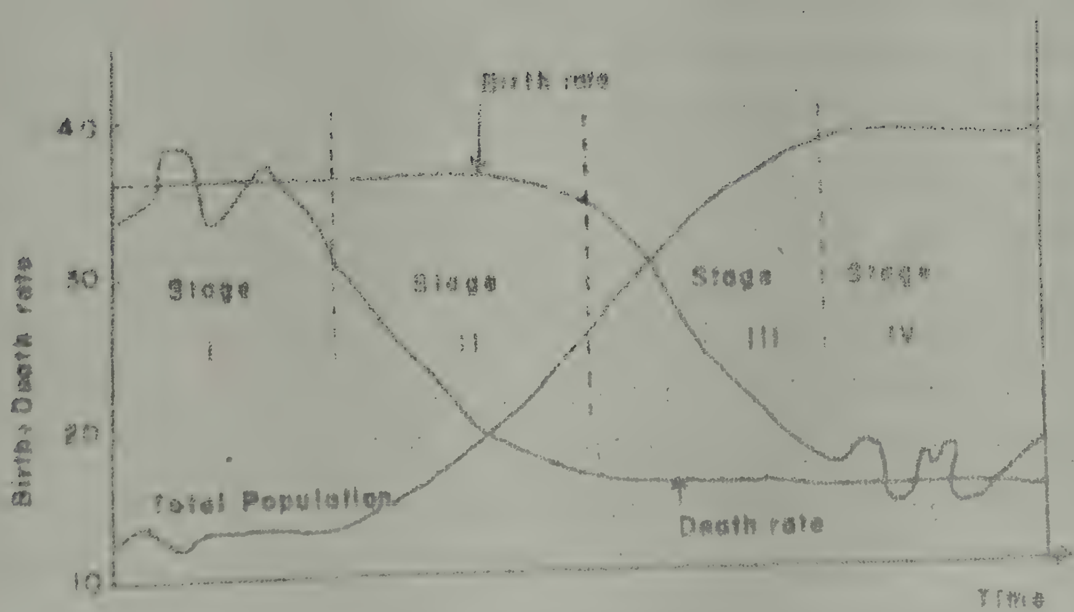

Birth rate
40
30
20
10
Birth+Death rate
Stage I
Stage II
Stage III
Stage IV
Total Population
Death rate
Time

Fig.7.2

$\frac{d}{dt}$ = calculus method of stating rate of change per unit of time.

The expression states that the amount of growth is related to the size of the population; the larger it is, the faster it grows. It may also be written as

$$N_t = N_o(1 - r)^t$$

For easier compilation, we can write the formula as:

$$N_t = N_o e^{rt}$$

where $N_t$ = number of people at time t;
$N_o$ = number of people at time o;
e = 2.71828 (natural log); and
r = rate of natural increase.

If we start with 1,000 people ($N_o$) and assume a growth rate of 1 per cent per annum (r = 0.01), then we can show by substituting these values in the equation that after 70 years (t = 70) the original population will have doubled ($N_t$ = 2000). We should note here that this method does not take note of migration. Moreover, it assumes that the present trends of growth would continue in future too.

The above method of population projection is useful only for short-run projections because it refers only to biotic potential of the population, i.e., its theoretical rate of growth without environmental limits. We know that a number of checks - natural and/or cultural - start operating so that the population increase remains adjusted to carrying capacity of the area.

We can introduce the environmental resistance into our model by the term:

$$1 - \frac{K - N}{K}$$

where K = maximum number of individuals allowed by the carrying capacity

and combine this with our expotential growth model to obtain the equation

$$\frac{dN}{dt} = rN - \frac{K - N}{K}$$

where r = rate of growth per individual
N = total population or density of population.

The growth curve that we get when we use the above formula is of S shape and is called Logistic growth curve wherein the rate of increase is modified as numbers approach the critical level. Such a solution does, however, imply more knowledge about environmental limits and more social control over births than presently existing in human groups.

There are several other methods to project population. We do not propose to discuss them all here. For rural area development planning, the exponential method is adequate, provided that migration is also taken into account. Migration is

$$M_t = (P_t - P_o) - N_t$$

where $M_t$ = migration during t year
$P_t$ = population in t year
$P_o$ = population in base year
$N_t$ = net natural increase during t years.

2. Stages of population growth:

It would not be out of place to mention here the hypothesis of demographic transition which is so relevant

to developing countries. While forecasting the populatio
this hypothesis should be kept in view.

Demographic transition is an idealised sequence of changes over time in vital rates. We can recognise four connected phases in this sequence:

i) High-stationary phase
ii) Early expanding phase
iii) Late expanding phase and
iv) Low stationary phase.

Graphically, it can be presented in the form given fig. 7.2. (p.105). In high stationary phase, birth and death rates are high, while in the low stationary phase they both are low. During the second phase death rates decline fast but birth rates remain stationary; while in the third phase the death rates become stabilised at a low rate and the birth rates come down drastically. The junction of phase two and three, records the highest rate of population growth.

3. <u>Pressure of population</u>:

Carrying capacity of an agricultural area depends largely on the man : land ratio, i.e., the number of people per unit of land. But we know that every piece of land is not equally productive. An acre of land in Rajasthan desert cannot be equated with an acre in Mandya district. Similarly the dry land cannot be equated with wet land. Methods have been devised, therefore, to classify lands in different categories. We would look into this in a later section. Here our problem is how to measure the pressure of population on land.

Density of population per unit of land is one indicator of pressure. But we encounter two conceptual problems here. First, as noted earlier, the quality of land is not the same everywhere, and second, the pressure will differ depending upon the standard of living we have in view. For example, 100 persons per sq.km. may be low if the expectations of the people are low, but it may turn out to be high, if the expectations are high.

Another factor that intervenes is the income generated outside agriculture. That part of the income which comes to the area of planning should be added to the income derived from land to get a realistic pressure of population on land. We have yet to perfect a method which can give dependable results. The best that we have at our disposal is:

$$I = \frac{P - P_1}{A}$$

where I = Index of population pressure;

P = Actual rural population;

A = Rural area in sq.km.

$P_1$ = Areawise derived rural population capable of being supported by the utilised land resources = $\frac{X}{K}$, where X = gross value of output of the area from primary sector at current prices; K = constant income per head from the primary sector desired for a slight improvement in the standard of living of rural population.

This formula can be further improved by (a) converting rural area into standard hectares; (b) adding to X the area income derived from other sources.

4. <u>Food requirement estimation</u>:

One of the main objectives of integrated rural area development is increased production of food. For proper

planning, we should know how much the area consumes, how much it produces, and what is the surplus or deficit. For estimating the local requirements of food, we can use the following formula:

$$TR_e \; \frac{T.P \times R_{ph} \times 86}{100}$$

where, $TR_e$ = Total requirements of cereals in the area;

$TP$ = Total population of the area

$R_{ph}$ = Cereal requirement per head = 190 kg per annum; and

$\frac{86}{100}$ conversion factor for adult units.

Standard deductions are:

Seeds = 6% (3.5 to 14 per cent)

wastage = 10%.

It is estimated that with about 200 kg. of cereals per head per year, (about 20 ounces per head per day), we can maintain a fairly high level of nutrition in the country.

## B. Interaction Analysis

Different areas and places interact with each other leading to movement of people, goods and information. Area planner should know something of the interaction models so that he can appreciate the implications of implementing various projects in his area. Let us take the case of a project to establish agricultural market yard in an area. There are yards in surrounding areas. He has to find out the catchment area of the new yard before he can implement this project because unless he knows the marketable surplus, he cannot know definitely whether the project would pay. We can use the following variation of the gravity model to

get the boundary of the area of influence.

$$B_2 = \frac{D_{12}}{1 + \sqrt{\frac{M_1}{M_2}}}$$

where $B_2$ = Break point in distance units from market yard 2

$D_{12}$ = Distance between yards 1 and 2

$M_1$ = Market size of yard 1

$M_2$ = Market size of yard 2

The above model is derived from the basic Newtonian gravity model which states that two bodies in the universe attract each other in proportion to the product of their masses and inversely as the square of their distance. This concept was introduced by W.J. Reilly in 1929 to the study of trade areas. We can estimate the spatial interaction between two regions or areas by multiplying together the mass of two regions and dividing it by some function of the distance separating them. Mass has usually been equated with population.

Population as a mass can be further refined by multiplying it by per capita income or some other weight. Similarly, the distance could be measured in terms of costs or travel time. The formula to measure the interaction is:

$$F_{ij} = a \frac{M_i M_j}{Dij^b}$$

where Fij = Flows between regions i and j

$M_i M_j$ = Mass of regions i and j

Dij = Distance between regions i and j

a = Empirical constant; and

b = Distance exponent.

## C. Natural Resource Analysis

### 1. Plant productivity:

The Swedish geographer, Sten Paterson, determined that productivity of plants increases with the length of growing season, the average temperature of the warmest month, the annual precipitation and the amount of solar radiation and it decreases with temperature range. By combining these values into a single index, we can give numbers to stations indicating their potential for plant growth. The formula is:

$$I = \frac{Tm\ PGS}{120(Tr)}$$

where I = Index of plant productivity

Tm = Average temperature of the warmest month in degrees Centigrade.

Tr = Annual range of temperature between the averages of the coldest and warmest months in degrees Centigrade.

P = Precipitation in centimetres

G = Growing season in months, and

S = Solar radiation expressed as a proportion of radiation at the poles.

This formula gives only the potential plant productivity; it only measures what plant life a particular environment could support in terms of climate. The actual plant cover reflects other factors such as the vegetational history of an area and the degree of human interference.

### 2. Rainfall variability:

While planning for a rural area, one problem that we always encounter is the rainfall variations and their implications for land utilisation. Some areas get too much

rainfall, while some get too little in a year. But the total rainfall in a year is not that useful an indicator of climatic potential of landuse. We must know also the variations in rainfall in time and space. Temporal (time) variation means how the rainfall is distributed throughout the year, monthly or weekly. If there is adequate rainfall during the months or weeks which constitute the growing season, crops can be raised well, even though the other months may be dry. So a total rainfall of 30" distributed almost equally among 4 months is more useful for agriculture than one distributed equally among 9 months. But if much of it falls in one month alone, it may not be of much direct use - in fact, it may prove injurious to soils.

One method of estimating the usefulness of rainfall is the index of de Mortonne/Lauer:

$$i = \frac{12n}{t + 10}$$

where n = average monthly precipitation amount in millimetres;

t = average monthly temperature in Centigrade; and

i = aridity index.

The boundary between aridity and humidity is reached when i = 20; a higher index indicates humidity, a lower aridity. It should be noted here that for agro-climatological purposes, an effective dry period is a period of three consecutive months during which precipitation is less than 4 inches (102 mm) per month. This is the minimum amount of rain needed for cultivation of crops and hence to maintain agricultural landuse.

Variability of climate can also be measured statistically. Standard deviation ($\sigma$ = <u>Sigma</u>) is the more widely

used measure of variability. It is calculated by summing the square of the deviation of each value from the average, dividing by the number of cases and then taking the square root.

$$\sigma = \sqrt{\frac{\sum(xi - \bar{x})^2}{n}}$$

where x = an individual value

$\bar{x} = \frac{\sum xi}{n}$ (the mean or average)

n = number of cases

$\sum$ = Sum of all values for i = 1 to n

Variability of rainfall may be compared between stations if the standard deviation is expressed as a percentage of the mean (co-efficient of variation, CV)

$$CV = \frac{\sigma}{\bar{x}} \times 100 ($$

3. Water resource assessment:

In 1945-46, Khosla evolved the following relationship describing run off as a function of rainfall and temperature. The method is useful for assessing water resources for large river basins. But it is less useful for small watersheds where topography plays a significant role in run off. Khosla formula is:

$$Rm = Pm - Lm$$

where Rm = monthly run off in cm.

Pm = monthly rainfall in cm.

Lm = monthly evaporation losses in cm = 0.481 Tm

Tm = mean monthly temperature in °C

. Water requirements for agriculture:

Blaney and Criddle derived an equation in 19.. which is widely used for estimating the water requirement of crops. It is written as:

$$U = Kf$$

where U = monthly evapotranspiration in inches referred to as consumptive use.

K = Crop constant

f = monthly evapotranspiration factor = $\frac{t \times p}{100}$

t = mean monthly temperature in degrees Fahrenheit

p = monthly per cent of day time hours of year.

The consumptive use coefficient (K) varies from month to month and has to be derived empirically.

5. Ground water balance equation:

The amount of ground water available in a particular area can be expressed by the formula:

$$G = P - (E + R)$$

where G = recharge of ground water

P = average precipitation multiplied by the area of the basin

R = run off

E = evapotranspiration.

D. Economic Base Analysis

Productive activities, as we know, differ among themselves in many ways. We know the differences among agriculture, manufacturing, etc. All these activities are therefore classified in three classes:

1. Primary: Agriculture and related activities,
2. Secondary: Manufacturing, and
3. Tertiary: Transport, commerce, education, health, etc.

There is another way of classifying these human activities. The criterion for this classification is, whether the products of the activity are sent outside the producing region or they are used within the region. The exporting activities are classified as basic and the non-exporting ones as non-basic.

1. <u>The location quotient</u>:

Frequently, the study of a region's export - import relations begins with a simple analysis employing location quotient. This quotient does not require extensive data collection and processing. It is a device for comparing a region's percentage share of a particular activity with its percentage share of some basic aggregates. If Region A, for instance, accounts for 10 per cent of the national total of steel manufacturing, and the region's total income is 20 per cent of the nation's total, the region's location quotient (with income as base) for steel making would be 0.5.

A more elaborate way of calculating location quotient for an industry (i) in the given region is:

$$\frac{Si/Ni}{S/N}$$

where Si = Number of wage earners in industry i in a given region;

S = Number of wage earners in all industries in i region;

Ni = Number of wage earners in industry i in the nation; and

N = Number of wage earners in all industries in the nation.

Instead of number of workers, one may take income, value added, population or area as the base for calculating location quotient.

2. Location curve:

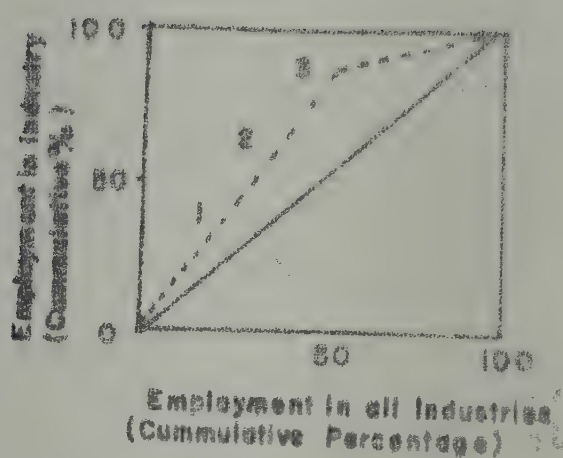
Another device to assess the position of a region in a system of regions is localization curve. It is constructed from a set of regional percentage figures by plotting on the vertical axis the cummulative percentage figures for the given industry's employment and on the horizontal axis the corresponding cumulative percentage figures for the base magnitude. The procedure involves (1) ranking regions by location quotients along the relevant row; and (2) plotting regions by rank on a cumulative percentage basis. Suppose that we have a four region country - A,B,C,D. Location quotient for each region for a particular industry is: 1.33; 1.5; 1.17; and 0.43.

Since region B has the highest location quotient, its percentage in fig. 7.3 is plotted point 1. We then add A's percentage to B's and plot point 2 and add the two percentage to C's and plot point 3. Joining the points gives the localization curve. If the distribution is the same as in the nation as a whole, the curve would be closer to 45$^{o}$ line. Farther away from 45$^{o}$ line it is, more is the distribution (fig. 7.3).

3. Interregional flow analysis:

The location quotient and localization curve are indicative of the extent to which a region's activities are in balance. Additional data can be acquired about region's strengths or weaknesses in relation to other regions by resorting to interregional flow analysis. There are three types of flow analyses which are often used by area planners.

1. Commodity flow analysis,
2. Money flow analysis, and
3. Analysis of regional balance of payments.


100
0
100
1
2
3
Employment in all Industries
(Cummulative Percentage)

The commodity flow analysis deals with the physical movement of individual commodities and groups of commodities from and to the region. This analysis immediately points out the importance of imports as well as exports in a regional economy. If possible, a planner should collect historical data giving details of the amount and value of commodities of different types moving in and out of the planning area. Destination of the outgoing and origin of the incoming commodities should also be noted.

Apart from commodity flows, there are money flows, communication flows, human flows, etc., which also should be studied and analysed. To some extent, the money flow is nothing but monetarily evaluated commodity flows. But money flow is also in response to flow of services. People of region A, working in region B, send money orders and cheques from B to A. In a subnational planning situation, savings of one region can be spent in another region through the national banking system.

Closely related to commodity and money flow analysis is balance of payment analysis. The latter, however, considers a single region vis-a-vis the rest of the world and thus precludes the general interregional perspective captured by the commodity/money flow analyses.

The balance of payment statement gives all transactions between the planning region and the rest of the country and equates total inflows and total outflows. A typical statement may be as follows.

| Item | Export | Import | Net |
|---|---|---|---|
| A. Current Account | | | |
| 1. Commodity trade | | | |
| (a) Wheat | + 100 | - 10 | + 90 |
| (b) Ore | + 0 | - 50 | - 50 |
| ..... | | | |
| (n) Others | .. | .. | .. |
| 2. Service trade | | | |
| (a) Freight | + 200 | - 300 | - 100 |
| (b) Education | + 250 | - 100 | + 150 |
| ..... | | | |
| (n) Others | .. | .. | .. |
| 3. Gifts and unilateral transfers | | | |
| Total | + 2250 | - 1500 | + 750 |
| B. Capital Account | | | |
| Net Capital Movement | | | |
| C. Errors and Omissions | .. | .. | .. |

Under the current account would come only those transactions which are completed in a particular year. Those which spill over longer periods are covered by capital account. For example, if Rs.1000 worth of wheat is exported, money has come in and so it is recorded under current account export as plus. But supposing, it has gone as loan, then it would be entered under capital account as plus.

4. Regional multiplier:

It is the rate of the spread of impulses originating in any sector of the regional economy to other sectors. Such spreading in essence has a multiplying result. It

thus tells how growth in one sector induces growth in other sectors.

The concept of regional multiplier is a derivative of the concept of basic and non-basic activities. Basic activities are those which produce goods/services for export; and non-basic are those which produce goods/services for local consumption/use. The non-basic activities are also known as service or local activities; and the basic as export activities. The regional multiplier is equal to total (or increase in) employment in both basic and service activities divided by total (or increase in) basic employment. The unit of measurement may be employment, production, value added or any other convenient unit like income.

The formula for the calculation of multiplier is

$$Ke = 1 + \frac{Se}{Be} \text{ or } 1 + \frac{Se_{t+\theta} - Se_{t}}{Be_{t+\theta} - Be_{t}}$$

where Ke = Employment multiplier

Be and Se = Employment in basic and service sectors

t = time (base)

$\theta$ = Period.

For example:

If total employment in basic sector = 1000 in 1950 and 1200 in 1970

Total employment in service sector 3000 in 1950 and 2400 in 1970

$$\text{Multiplier for 1950} = 1 + \frac{3000}{1000} = 4$$

$$\text{for 1970} = 1 + \frac{2400}{1200} = 3$$

$$\text{for 1950-70} = 1 + \frac{1200}{200} = 7$$

While the concept of multiplier is simple, the data for it are difficult to find. In the first place, it is very difficult to identify in clear terms, basic and servic components of an economy. Most firms produce goods both f export and for internal use. Adequate data to allocate export and import component of each firm are not available in India. Another issue often raised is the dependability of past data for prediction. The technology may change and it may have its own implications for basic - non-basic ratio in the future. Nevertheless, it is a useful tool of analysis in area planning.

## Chapter VIII

## METHODS AND TECHNIQUES USEFUL IN INTEGRATED AREA DEVELOPMENT PLANNING - II

In this chapter, we propose to discuss a few more methods and techniques useful in area development planning. No attempt is made to illustrate the methods with examples, as this would be attempted in Volume III of the report.

### A. Indicators of Development

Several attempts have been made in the past to work out indicators of development. The idea is to find quantitative measures for determining the relative poverty or richness of an area. Quite often per capita income is taken as an indicator of development. But, we do not have income data for areas smaller than a district. Moreover, income as the sole indicator of development is also questionable. There are many other factors which determine development and quality of life.

The average per capita income may be so distributed among groups of people, and areas, that a few may enjoy luxuries and while a majority may fail to get even basic necessities. Availability of education, health, communication and other services is an equally important indicator of development. Other indicators are sectoral employment and output, use of modern technology in productive and service sectors. Keeping all these in view, a number of people have developed indices of development. The indicators which are commonly included in the test consist of:

1. Per capita income
2. Working population as per cent of total population

3. Urban population as per cent of total population
4. Factory employment (daily) per 1000 population
5. Per capita factory output
6. Irrigated area as per cent of cropped area
7. Per cent of area under crops
8. Fertilizer consumption per hectare of cropped area
9. Per capita electricity consumption
10. Length of surfaced roads per 100 km. of all roads
11. Motor vehicles per 100,000 population
12. Percentage of children in school, and
13. Daily newspaper circulation per 1000 population.

There are cases of more than 100 indicators being used. The values of the indicators are added together and placed in descending order areawise. The total of all indicators is often called composite indicator or index of development. In a particular year, the area getting highest index will be counted as best developed.

Several analysts use factor analysis to identify one to three major factors which account for development. We would not elaborate the methodology of factor analysis, as it is too sophisticated to be of much use in rural planning activities. Further, it suffers from many limitations and hence should be used only if one knows fully well the drawbacks of this technique.

The index method also suffers from many drawbacks. In the first place, all indicators of development are treated equal. In real life, it is not so. Secondly, what appears to be a set of indicators is in reality nothing but the consequence of something which is yet to be understood, or it may be the interrelationships among various

indicators which is the real cause of development, not the indicators themselves.

Notwithstanding the above drawbacks and shortcomings, the index method of determining the degree of development of an area (in comparative terms) is the best and the simplest which field workers and micro-level planners with limited facilities can fruitfully use.

B. Industrial Complex Analysis

Industrial complex is a set of activities occurring at a given location and belonging to a group of activities which are subject to important production, marketing or other interrelations. Complexes may be of three types:

1. Comprising of successive stages in the production of an end product;
2. Joint production of two or more commodities from a single class of raw materials; and
3. Two or more of basic raw materials and intermediate products combine to form two or more products.

Figure 8.1 shows the links in an industrial complex. It gives a simplified example in which fertilizer and synthetic fibre production is linked to the basic oil refinery.

Industrial complex analysis can become a very useful tool in rural area development. If the main activities of an area are confined to agriculture, one can think of an agro-industrial complex. As explained through fig. 8.1 there are two types of link activities which can be built around a basic product/activities: (i) final products for consumption and (ii) raw materials for other industries. The whole concept can be further extended to cover marketing, servicing, etc. also.

While planning for rural area development, it would be useful to identify a few products around which agricultural or agro-industrial complexes could be developed.

PETRO-CHEMICAL COMPLEX

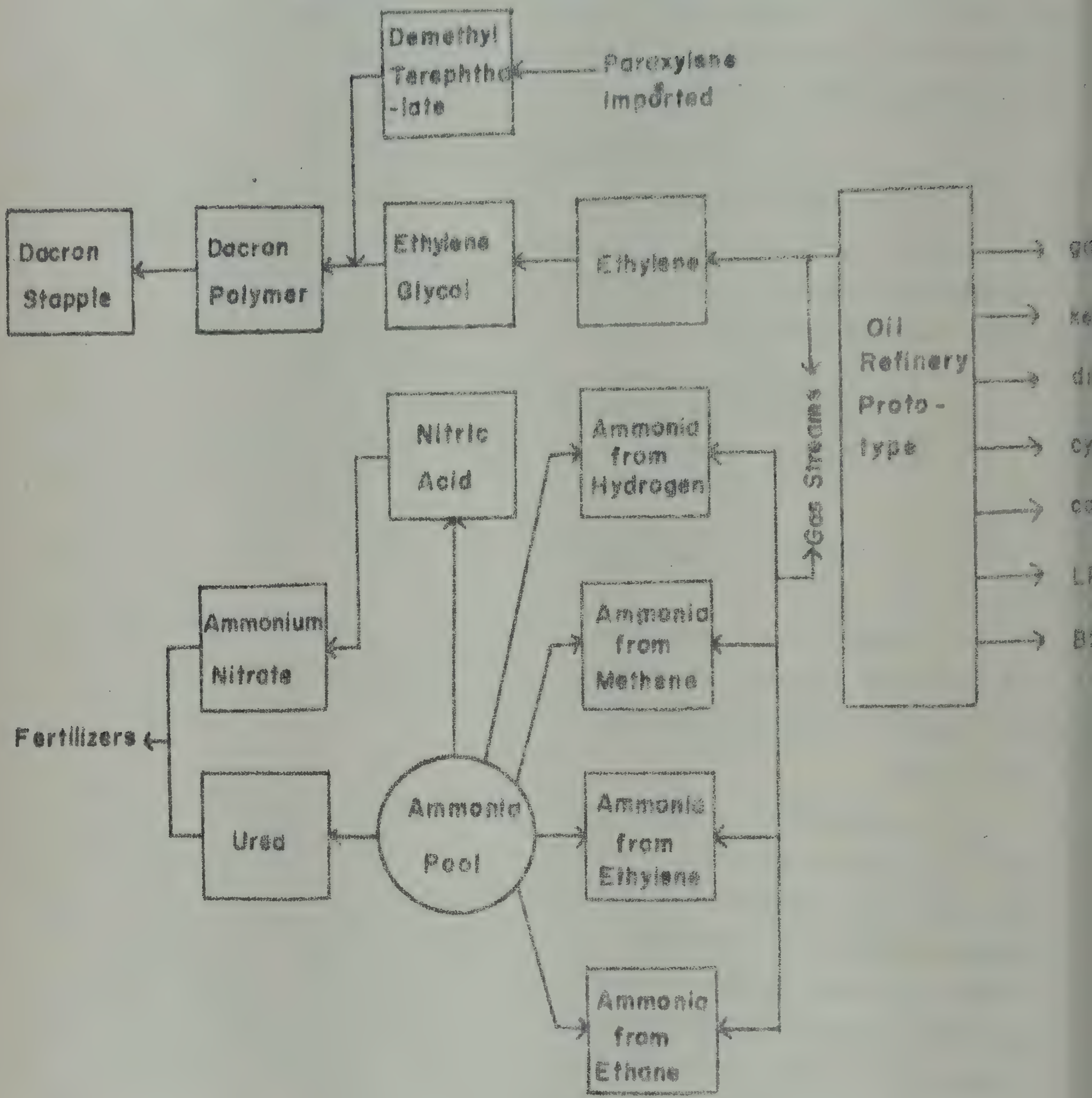



Fig.8.1

DAIRY COMPLEX

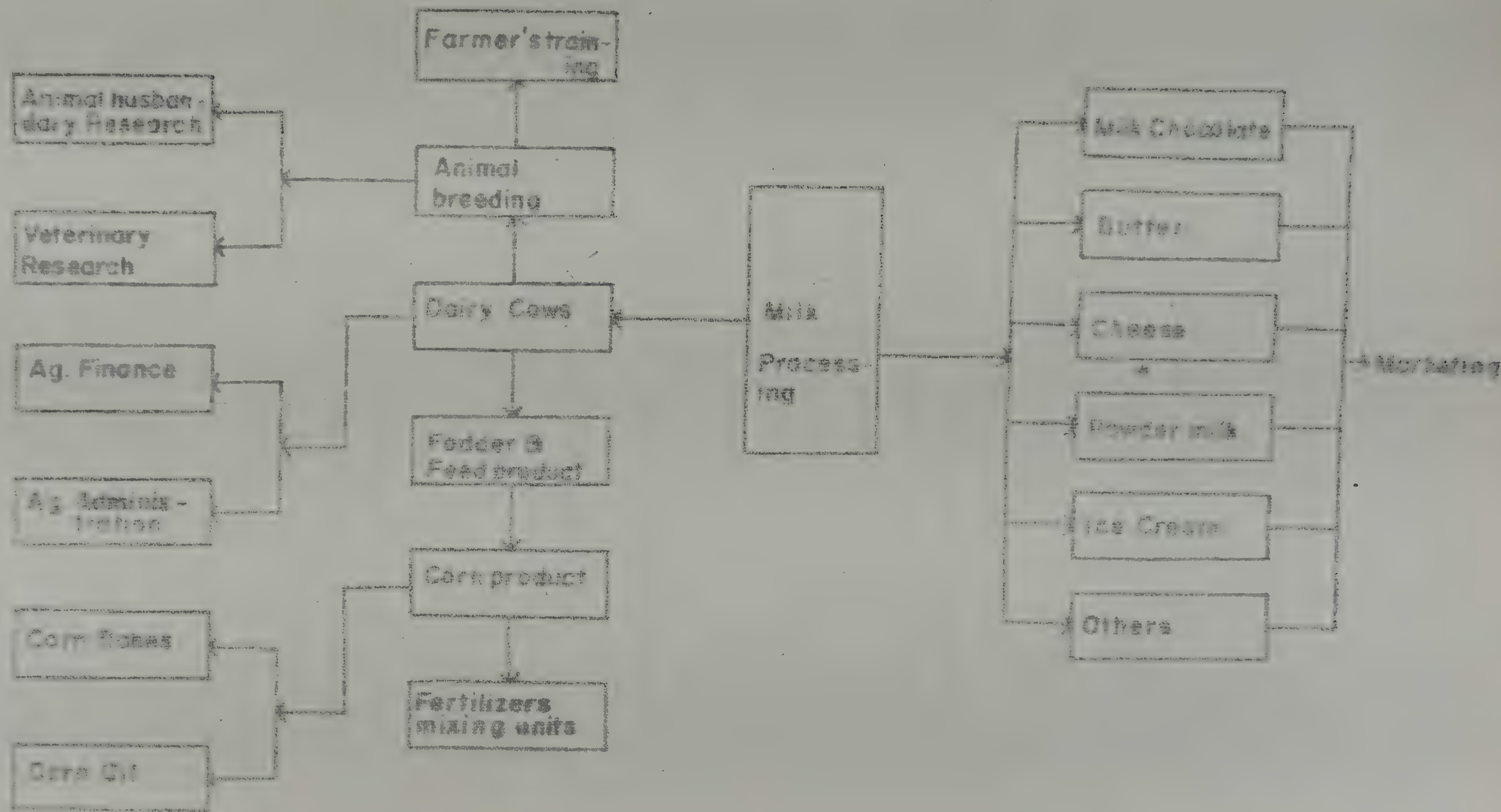



Fig. 8.2

Even if one such complex is developed in the area of opera-tion, it would provide enough incentives for more inte-grated ventures. The role of co-operatives and the public sector agencies is quite important in this regard. A case of dairy complex is given in fig. 8.2.

C. Input-output Analysis

As apparent from industrial complex analysis, various human activities are mutually interconnected. The output of one activity is used as input by many others. It means that we cannot develop a selected activity without taking care of the other products which go as raw material or other activities which use the final product. Input-output analysis, also known as inter-industry analysis, is a fruitful approach to depict and investigate the inter-linkages among various activities.

Input-output technique tells us how the output of a particular sector of activity is used by other sectors of activity. It does so with the help of a flow table (fig. 8.3)

The table reveals how the gross out-put of agriculture (row 1) is used by various sectors. Similarly, it also tells how much agriculture buys from other sectors (Column 1). The total input in agriculture is equal to total output. In other words, it tells that to produce 100 rupees worth of agricultural products, the inputs required are: Rs.13 from agriculture, Rs.20 from manufacture, Rs. 12 from transport, etc. If the other sectors are not developed enough to contribute these inputs, agriculture cannot pro-duce Rs.100 worth of goods. So, planning of agricultural development cannot be done in isolation. Same is the case with all other sectors.

| Purchasing sector / Producing industry | Agriculture | Manufacturing | Transportation | Trade | Households | All others | Total gross output |
|---|---|---|---|---|---|---|---|
| 1. Agriculture | 13 | 15 | 10 | 20 | 22 | 20 | 100 |
| 2. Manufacturing | 20 | | | | | | |
| 3. Transportation | 12 | | | | | | |
| 4. Trade | 5 | | | | | | |
| 5. Households | 40 | | | | | | |
| 6. All others | 10 | | | | | | |
| Total inputs | 100 | | | | | | |

fig. 8.3 - Table showing input - output flow.

In fig. 8.3 we have shown only six sectors. But this is not a realistic model of the economy. One can have as many sectors as the data constraints permit. Input-out tables with more than fifty sectors are quite common. No effort has so far been made to prepare input-output tables for villages, groups of villages or districts.

The concept of input-output may be further expanded to develop interregional input-output tables which would show which sector of which region buys the products of a region and supplies the inputs of various products of a region.

## D. A Composite Approach to Agricultural Development

### 1. Introduction:

The increasing interest shown by social scientists in problems of development during the last two decades or so has given rise to a number of theories and approaches. Although many of these theories and approaches provide deep insights into certain aspects of development, they do not offer any general conceptual frame which can be used by planners and policy makers in formulating action programmes designed to promote development.

These theories and approaches have two basic limitations, which have great implications for development in general and agricultural development in particular. In the first place, they attempt to seek a single positive catalyst or 'primum mobile' which can generate a positive process of development and do not take into account the totality of the environment within the framework of which developmental processes work.

In the second place, these theories and approaches have been formulated with a view to solve the problems associated with industrial expansion and growth and not those of agricultural development and change. There appears to be an implicit assumption that the problems of development are essentially those of industrial development. This assumption is unrealistic because it is the agricultural sector that is the foundation on which the economies of most of the underdeveloped countries of the world have to be built.

There are several reasons why agricultural development is so basic to economic development in the underdeveloped countries. In order that developmental processes become a lasting reality, they must emerge from within and conform to the genius of the people. As Pentony has remarked they "cannot be imported from abroad" and transplanted anywhere and everywhere by experts in the narrow sense of acquiring certain technical skills made available by developed countries.[1] In countries or regions where more than 80 per cent of the available labour force is trained in nothing but certain rudimentary methods of agricultural operations and where there is hardly any industrial base to start from, agricultural development may by necessity of circumstances take precedence over industrial development.[2] The history of economic development in many of the present day developed countries also points to the fact that improvements in

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1. De Vere E. Pentony (ed.), <u>The Underdeveloped Lands - A Dilemma of International Economy</u> (San Francisco: Chandler Pub. Co. 1960), p.9.

2. This is not deny the close interrelationship between agricultural development and provisions for industrial development. A plea for agricultural development presupposes a rapid development of those industries which have direct bearing on agriculture.

agriculture came first.

By its very nature, agriculture is unable to develop the seeds of its own transformation. Confined to small operational units, isolated from large population centres, and subjected to the inescapable rhythm of nature, agriculture in backward economies tends to become 'a way of living' rather than 'a way of getting a living'. And being bound so crucially to extensive space and a biological time schedule, it is unable to create the conditions that are so typically responsible for the creation of large plant units in the industry.

In such circumstances there is no hard and fast line to be drawn between agriculture and all other economic functions. Agriculture, agricultural industry and kitchen work are one uninterrupted and interlocked chain of functions. The present day economic theories are not based on the empirical studies of such agricultural systems.

What then should be the nature of a theory or approach which can explain the processes of agricultural development better than the existing ones do? Only that approach which treats agriculture as a system formed by a number of interdependent and interacting sub-systems which acquire meaning and substance only when they form part of that system, can adequately explain these processes. Even a casual visit to a peasant farm in any part of the world points to the fact that the life of the peasants engaged in traditional agricultural systems functions within the framework of a composite environment, the individual elements of which cannot be treated independently without doing injustice to the reality of the situation or without running the risk of misconception or self-delusion.

The purpose of this section is to suggest an analytic framework or model which treats agriculture as a system formed by a number of variables which are inextricably linked with each other and which point towards a geo-economic strategy for tackling the agricultural problems of the underdeveloped countries of the world.

Each rural community organises its agricultural resources in its own unique way. Even those communities which exist in the same habitat differ in their methods of resource organisation. For example, the Old Order Amish of Lancaster country, Pennsylvania, organize their agricultural resources in a fashion that no other group living in the same habitat does. Students of agriculture will not be hard put to multiply examples so as to show that such anomalies are universal and not typical of any one region or country.

The different types of agricultural systems can be grouped into two broad categories.

1. Those systems in which the constituent elements either remain unchanged for a long time or change too slowly to be perceptible over decades or even over scores of years. Such systems possess a relatively fixed and determinate structure of their constituent elements which is handed down from generation to generation. Since newer elements cannot penetrate such systems easily, the productivity per unit of land is low. Usually such systems are also characterised by low per capita productivity. The types of farming characterized by such agricultural systems may be referred to as traditional, or underdeveloped agriculture.

2. Those agricultural systems which do not possess a determinate structure of their constituent elements. In these agricultural systems new elements are constantly added and old ones subtracted with much less resistance. What elements are included in these systems depends largely on the economic gains to be derived from them in the market and not so much on tradition, custom or belief. The types of farming characterized by such systems may be referred to as modern, or developed agriculture.

The problem of changing a traditional underdeveloped agriculture with a fixed and determinate structure of constituent elements into a developed agriculture with a dynamic and indeterminate structure of constituent elements, involves two closely related processes.

1. The introduction of economically gainful elements which are absent from the system.
2. The substitution of all non-gainful or relatively less gainful elements which are already present in the system by elements which are more gainful.

What are the elements which are likely to be incorporated in a given agricultural system? What should be the rationale of policy decisions in this regard? Why is it that certain elements are readily incorporated in an agricultural system, while others are rejected? The answer to these and many other related questions lies in the understanding of the composite environment a model of which is presented below.[11]

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11. For further exposition, see R.P. Misra, _Diffusion of Agricultural Innovations_, 1968.

2. <u>Model of an Underdeveloped Agricultural System</u>:

Given the present stat~ of agricultural technology in the world, agricultural geographers can tell, at least theoretically and approximately, what crops and animals can be raised in a given habitat. Location, land forms, soils, climate, flora and fauna put certain limits on the choice of elements. Even if areas of extremes of climate as the polar regions and much of northern Africa are excluded as essentially uninhabitable, one will find that natural limitations on the choice of crops and animals are manifest everywhere. For example, certain crops can be grown in regions of temperate climates and only certain others only in regions of tropical and subtropical climates.

Vogt interpreted and conceived the physical limits in terms of biotic potential.[1] He severely criticised the agricultural planners and policy makers for trying to solve agricultural problems while ignoring the biotic potential and carrying capacity of land. Williams also concurred with Vogt when he stated that in order to satisfy the national interest agriculture's "system of production must be well adapted to the physical circumstance, especially to climate. Economic circumstances clearly also influences the

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1. Vogt stated his theory in the following symbolic form:
$C = B:E$
where C = Carrying capacity of land
B = Biotic potential or the ability of land to produce crops and to sustain animals of different kinds.
C = Environmental resistance, or the limitations that any environment, including the part of it contrived and complicated by man, places on the biotic potential.

choice of system, but economic factors can operate only within the limits set by physical conditions".[1]

Let these physical limits on the choice of elements be shown by a circle P within a rectangle R in fig. 8.4. The rectangle R encompasses all those elements which can be combined together to form an agricultural system anywhere in the world. The elements naturally are very large in number and can be indicated by a symbol x. The circle P delimits all those elements the existence of which is physically possible in a given habitat. In certain areas P will be large, while in certain others it will be small, depending upon the favourableness of the natural environment.

All those elements which are physically possible in a given area may not necessarily be available to the inhabitants of that area. They cannot really become part of their agricultural system, unless they are in conformity with their cultural values. Before these elements can be accepted they must, therefore, go through a process of selection and screening. In this process, the first test these elements have to pass is the test of cultural compatibility. As the process of selection and screening continues, some of the elements are accepted readily, others are cast aside indifferently, while still others are rejected outright. For example, if the Government of India should want to develop beef industry in India it is not likely to succeed, because eating of beef is incompatible with the cultural values of the Hindus who constitute majority of the population of India. Likewise, there is no

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1. T.H. Williams (editor), Principles of British Agricultural Policy (Oxford: Oxford University Press, 1960), p. 141.

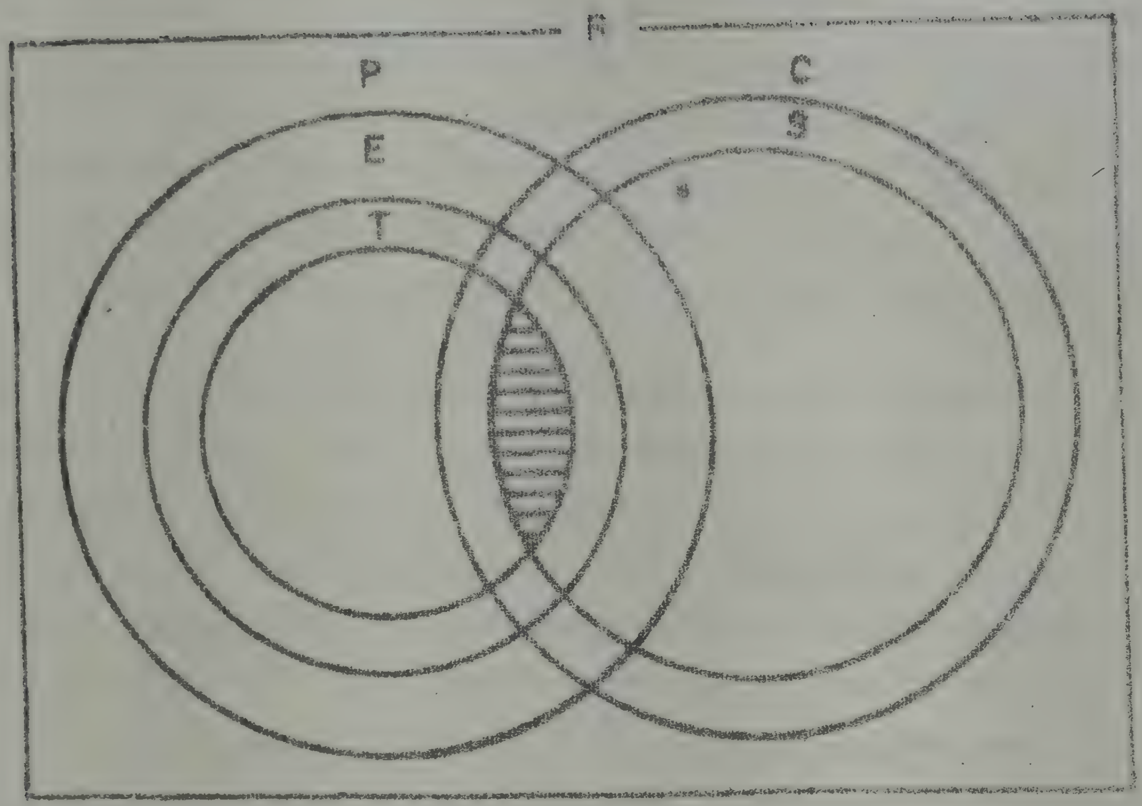


Fig. 8.4

chance of hog raising being accepted as an element in the agricultural systems of the countries where Moslems form a majority. Similar cultural restraints exist in all societies. Sometimes these restraints are explicit and at other times, implicit. Let all those elements which can be culturally available to the farming people of the area in question be shown by a circle C within rectangle R in fig. 8.4. Circle C encompasses all those elements which are culturally available to the farmers.

P and C may or may not overlap each other completely. In almost all cases they will not. The part overlapped covers those elements which are physically possible and culturally available. The elements which lie within P but not within C are only physically possible and those which lie within C but not within P are only culturally available. The sizes of circles P and C point to the fact that the physical and cultural restrictions are not as coersive as those represented by T, S and E (fig. 8.4). Being less coersive in nature, these restraints provide considerable scope for development through technological and socio-economic changes in agricultural systems. In fact, even in the most developed areas of the world, all the elements that can be said to fall within P and C are not exploited by the farmers. These two restraints may thus be said to put a sort of theoretical ceiling to agricultural development. Within these theoretical ceilings there exist a number of practical ceilings which result from the state of technology, social and political institutions and economic organization of the society.

Since, it is generally not possible to incorporate an element in an agricultural system which lies outside the boundary of either P or C, prudence and practical judgement

would suggest that such elements be excluded from the plans for effecting agricultural changes in any given area at any given time. Failure to realize the significance of these two primary restraints brought many a frustration to those who attempted to change agriculture in many underdeveloped countries. It may be pointed out that because of the differential effects of changing technological socio-political and economic factors, agricultural development is likely to be faster in areas where the potentials shown by P and C are large than in areas where the potentials are small. This is particularly so in the initial stages of development when the level of technology is very low. One of the most important initial steps in planning for agricultural development is, therefore, to understand well the restrictive forces of P and C.

Apart from P and C there are three other restraints which limit the choice of elements. These are T, S and E. Agricultural technology offers the means by which the elements lying within P and C can be exploited. In areas where technology is backward, only a small part of the potential resources is actually used by the people. Technology, however, never reaches a level of development at which all potentials can be exploited. This is because with each change in technology the potentials are also likely to increase, and also because technology is always tied up with the socio-political and economic factors. In any case, at any given time in any area technological restraints are always obvious, and can be represented by another circle T within P. As T expands, the number of elements available

to the farmers also increases. It may thus be stated - at least hypothetically - that other factors remaining the same, and within the limits set by P and C, agricultural development is a function of technological change.

Technology is, however, not only related to the physical and cultural environments but also to the socio-economic structure of the society in question. Thus in addition to T, there are two other restraints which further reduce the number of elements to be included in an agricultural system. One of them is E or economic restraints. E is an important restraint because unless an element is found economically gainful, it is not likely to be adopted by the people. For example, unless dairy farming is more gainful than general farming, there is no reason why farmers should change to dairy farming. Let the economic restraints be represented by a circle E within P and T in fig. 8.4.

Strangely enough, farmers do not always combine such elements which are economically gainful. There is indeed an incentive for them to employ only economically gainful elements in their production processes, but there is also an incentive to employ those elements which are socially desirable. For example, a tractor is an economically gainful element and ought to be adopted by the farmers in Lancaster Country, Pennsylvania, but the Old Order Amish[1] still continue to use horse power mainly because a tractor is considered to be a socially undesirable elements. Similarly the redistribution of land in many countries of Latin America may be an economically gainful proposition, but the governments of these countries have so far found it a socially undesirable change. Let these socio-political restraints be represented by circle S within circle C.

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1 . A group of settlers of German origin.

Now what are the elements that are likely to form part of an agricultural system? Clearly, these will be the elements which lie within the circles P,C,T,E and S at the same time. If the number of elements encompassed by the overlap of all these circles is small as in figure 8.4, that agricultural system, by definition, is underdeveloped, but if it is large, that system, again by definition, is developed or is in the process of development. The distinction between the two lies in the fact, that the underdeveloped agricultural systems, having a large number of elements are complex. It may be recalled that agricultural development, as used in this study, is a relative phenomenon. It is difficult to state in definitive terms, which agricultural system is more developed than the other. Such is possible only in relative terms.

3. <u>How underdeveloped agricultural systems function</u>:

In underdeveloped agricultural systems not only the number of resource elements is small, but there are also a considerable number of elements in the system that are not economically gainful. If the agricultural system is organised on an economically rational basis, all the elements must lie within the sector encompassed by P,C,T,S and E, i.e., the cross-hatched area in fig. 8.4. But as apparent from this figure the hatched area extends beyond E to circle T. The elements that lie between E and T (single line hatched area in fig. 8.4) are technologically available and socio-politically desirable but economically non-gainful. Nevertheless, many of these non-gainful elements are included in the underdeveloped agricultural systems. An example will illustrate this point better. Many farmers in northern India keep large herds of cows, chiefly because a large herd is the sign of economic prosperity. The author, during

one of his investigations there, found that the cost of keeping a cow per year far exceeded the returns from it. It may be remembered that most cows in India do not give more than half a pound of milk per day; their chief contributions are the dung which is used as manure and the power of the bullocks which is used for plowing. Now from a purely economic point of view, these farmers lose economically but they get many social benefits out of their large herds. They are respected by other farmers and are also able to donate some of the cattle to their relatives on various occasions. It is not suggested that the practice of helping others is undesirable. It is suggested, however, that farmers in underdeveloped areas are less of an economic men than their counterparts, say, in the United States or most of the West European countries.

In a society which has continued for a long time without basic changes, the total environment surrounding the members of that society attains some sort of permanency and seems to satisfy the purposes and motivations of its members. Many of the elements included in the agricultural systems of these societies, are not economically gainful. This situation is, however, not accidental; it serves certain basic social purposes and needs. The elements included are not likely to be traded for other elements that do not serve those needs and purposes. Alternatively, the purposes and needs of the society itself would have to be changed if currently excluded gainful elements are to be included.

A peasant in a traditional society is not a technologically and economically alert person. In the relatively unchanging world in which he lives, he depends on his fellow peasants for help and assistance. This he can do only if

he maintains a close interpersonal relationship with his fellow men. He, therefore, clings to tradition with stubborn resistance and often with superb confidence, skill and endurance. But whenever he finds that he can change a situation to his advantage, he exploits the opportunity with the same skill and confidence. That is why an outside observer might conclude that the peasant in such countries has a split personality; in certain respects he is rational, but in certain others he is stubbornly traditional.

There are always two powerful forces acting and reacting on a peasant in the underdeveloped area. Economic advantages impel him to select those elements which are economically gainful to him and his family, but his practical judgement, born out of his sense of helplessness and fatalism in the face of unalterable natural and social forces, impel him to seek security in customary practices, and thus select elements which are economically non-gainful, but in conformity with established practices. The peasant's desire for economic betterment inspires him to experiment and change, while his dependence upon his fellowmen and women motivates him to conform and resist change.

If one looks at the peasant as a part of a composite environment, and not of only a natural and/or an economic environment, one is better able to perceive the reasons why changes in the traditional societies are slow. It is empirically right to state that farmers in the traditional societies resist change, but it is also right to state that they can accept change. It depends on how one looks at the problem. As remarked by Spicer, "the notion that people tend to resist rather than accept change may be a special idea of our era, formulated by those who are especially conscious of

cultural differences or by those who are engaged in trying to bring about change. To the latter, certainly, the fact of resistance is more striking than acceptance".[1]

Because of stagnation or imperceptible changes over centuries, all factors, including the physical and cultural i.e., P and C are at equilibrium at the level shown by the hatched section in fig. 8.4. Although P indicates a large potential, only a very few of the potentially available elements are actually used; and hence for all practical purposes P coincides with T. Likewise, C coincides with S. Thus the boundary within which the actual elements exist is formed not only by T and S but also by P and C. E lies in between these restraints from a self perpetuating vicious circle as described by Myrdal in his Rich Lands and Poor.

4. How underdeveloped agricultural systems change:

The approaches and theories prevalent at present imply that change in one or the other factor of the total environment, can transform an underdeveloped agricultural system into a developed one. Stated symbolically, they prescribe that,

Agricultural development - f ( P or C or T or S or E) i.e., as Agricultural Development is a function of change in P or change in C or change in T or change in S or Change in E).

The composite approach explained in this chapter puts this model in the following symbolic form:

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1. Edward H. Spicer, (ed) Human Problems in Technological Change - A Class Book (New York: Russell Sage Foundation, 1952), pp. 17-18.

Agricultural development - f ( P, C, T, S, and E) where P,C,T,S and E are mutually interdependent factors and where changes in P and C are assumed to be qualitative and not quantitative.

This model shows how various factors involved in the process of agricultural development are interconnected and interlocked and points out that all of these factors do not have the same degree of fixity or flexibility. This interrelatedness explains well why many economically advantageous techniques are not adapted by the farmers in underdeveloped countries, or why just ten miles from the booming industrial city of Bombay, farmers live the same stereotyped life their grandparents lived a century before or why the Old Order Amish in Lancaster country, Pennsylvannia U.S.A., continue to use horse power in preference to mechanical power. Like other socio-economic systems the agricultural systems of the underdeveloped countries also have a critical range of flexibility. But this range is such that changes within the limits set by it, by and large, maintain the system intact. In order to bring a totally new structure of elements, the changes have to occur beyond this critical range. But any major change can occur only when the internal or external forces affecting the system demand a change beyond the critical range. The first reaction of any people to such forces is to recoil and resist. But as soon as it is realized that resistance to change is likely to undermine the whole system, more and more of them adapt themselves to new circumstances. As stated earlier, there are always two basic urges that inspire the people to action. One tends to push in the direction of gainful elements, the other toward the established practices. Resistance to change is derived from this tendency to conform to the established

practices. What is needed then, is the creation of conditions under which people in the rural areas of the underdeveloped countries not only have a more liberal choice of elements, but also the capability of making choices. Agricultural development, thus, not only entails economic development but also human development.

The solution of the complex problem of agricultural development involves a plan that is oriented not only toward the provision of capital or any other single factor of production but also of education, training, new social organisation, techniques, increased land resources, and many other day-to-day necessities of the farmers. To sum up, since the life of the farmers in the underdeveloped countries functions as a complex whole and not in isolated functional segments, any plan that is meant to change their agriculture must embrace all aspects of their life. In such situations a long-range composite community development plan oriented toward agricultural improvements is more likely to be successful than a crash programme designed to change the agricultural practices alone or a social welfare programme designed to change the values and social structure of a community.

# Chapter IX

## LANDUSE PLANNING*

To make a sound and comprehensive land use plan, two sets of facts are needed. One is an inventory of the land, which is best recorded on a map. The other has to do with facts about the farm business - available facilities, etc. It is necessary to know the carrying capacity of each hectare of land.

### A. Land Capability

Soil conservation technicians have discovered that the land inventory, in order to meet the needs for planning conservation farming, must be more than a soil map, erosion map, or a slope map; and yet it must be simple. It must show clearly the adjustments that are needed. It must be sufficiently detailed to allow separate treatments field by field or acre by acre if necessary. It was in response to these needs that the method of classifying land capability was developed.

Land capability refers to the suitability of land for specified uses. Farmland as a rule is used either for the production of crops requiring tillage or for some form of permanent vegetation (usually grass, other forage plants, or timber) requiring little or no tillage. In classifying land capability, answers to these questions are first sought: Is the land suited for the production of crops? Can it be cultivated without soil erosion? Is its safe and permanent use limited to the production of perennial vegetation?

Probably most farmers have made at one time or another in their own minds some kind of classification of the capability of their land. They know that some fields can be used for cultivated crops and that others are too steep,

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* An extract from A Manual on Conservation of Soil and Water, United States Department of Agriculture, Soil Conservation Service Agriculture Handbook No.61.

too stony, too thin, or too wet, for cropping. They know that some of their fields which are unsuited to cultivation make good pasture, and that still others are most productive if planted to trees. In a general way they know these outstanding facts about their land although probably they have never made a map of their farms nor even expressed all of these ideas in words.

Many farmers, however, have failed to realise fully that steeply sloping land cannot be farmed safely with level-land methods. They have plowed straight furrows and planted straight rows rather than change their farming to fit the land. This makes some of the rows run uphill and downhill, and every rain falling on an unprotected slope removes part of the soil. A few farmers, watching muddy water flow from their fields, have appreciated how valuable and how irreplaceable their thin layer or topsoil really is and have taken steps to check this kind of waste. But losses of soil for the most part come about so gradually that they are not fully realised. Farming habits, like any others, are difficult to change; moreover, precise recommendations for soil-saving measures have not been generally available to farmers. Therefore, it is not surprising that in the past farmers in classifying their land for use more often than not have neglected to consider the full significance of soil erosion.

Use and conservation of land are influenced by the nature of the soil, the degree to which it has been affected by erosion, the slope, the wetness of the soil or its droughtiness, and the climate. The climate must be considered because it affects the crops that can be grown and the density of vegetation, both of which help to determine the need for and the possibility of erosion control and water conservation.

Any one of these factors, or several of them together, may limit the possible use of land. The rate of soil erosion depends on several properties, as soil, vegetative cover, climate and steepness of slope. On some soils erodibility on critical slopes is the deciding factor in setting up classes of land suited for cultivation. On others, the combined influence of a high water table and low fertility may be dominant.

1. Facts obtained in the field:

The only dependable way of determining the capability of land is to make a careful examination of it in the field. This is done by soil scientists who walk over the ground, bore or dig holes in the soil, and determine its depth, texture, permeability, available moisture capacity, inherent fertility, organic-matter content, and other characteristics that affect the use, management, and treatment of the land. They measure the slope, determine the degree of soil loss by erosion, the overflow hazards, the wetness of the land, and other significant characteristics. They note also the present use of the land. These facts are recorded on aerial photographs for later use by farmers and others.

The factors used in mapping land are characterized by differences that significantly affect conservation practices, use suitability, crop yields, and management requirements. In interpreting what the land can do and what it needs, each of these land characteristics is considered in relation to all others.

The land characteristics and those significant ranges of each that have been found most generally to be meaningful are given below:

1. Effective depth of soil (as depth over rock, tough clay, or hardpan):

| | | |
|---|---|---|
| Very deep | .. | 60 inches or more |
| deep | .. | 36 - 60; |
| moderately deep | | 20 - 36; |
| shallow | .. | 10 - 20; |
| Very shallow | .. | 0 - 10. |

2. Texture of surface soil (fineness of constituent particles):

| | | |
|---|---|---|
| Very heavy | .. | (heavy clay; 60 per cent or more 2-micron clay particles); |
| heavy | .. | (clay, silty clay, sandy clay); |
| moderately heavy | | (silty clay loam, clay loam, sandy clay loam); |
| medium | .. | (silt loam, loam, very fine sandy loam); |
| moderately light | .. | (sandy loam, fine sandy loam); |
| light | .. | (loamy fine sand, loamy sand); |
| very light | .. | (sand, coarse sand). |

3. Permeability of subsoil:

| | | |
|---|---|---|
| Very slow | .. | (less than 0.05 inch of water percolation per hour); |
| slow | .. | (0.05 - 0.20; |
| moderately slow | | (0.20 - 0.80); |
| moderate | .. | (0.80 - 2.50); |
| moderately rapid | .. | (2.50 - 5.00); |
| rapid | .. | (5.00 - 10.00); |
| very rapid | .. | (10.00 or more). |

4. Permeability of substratum:

| | | |
|---|---|---|
| Very slow | .. | (less than 0.05 inch of water percolation per hour); |
| slow | .. | (0.05 - 0.20) |

| | | |
|---|---|---|
| moderately slow | .. | (0.20 - 0.80; |
| moderate | .. | (0.80 - 2.50); |
| moderately rapid | .. | (2.50 - 5.00); |
| rapid | .. | (5.00 - 10.00); |
| very rapid | .. | (10.00 or more). |

5. Thickness of surface soil:

| | | |
|---|---|---|
| Thin | .. | (0 - 6 inches); |
| moderately thick | .. | (6 - 12); |
| thick | .. | (12 - 24); |
| very thick | .. | (24 - 36). |

6. Available moisture capacity (inches of absorbed water per 60 inches of soil depth):

| | | |
|---|---|---|
| Very high | .. | (12 inches or more) |
| high | .. | (9 - 12); |
| moderate | .. | (6 - 9); |
| low | .. | (3 - 6); |
| very low | .. | (less than 3). |

7. Reaction

| | | |
|---|---|---|
| Acid | .. | (6.5 pH or less); |
| neutral | .. | (6.6 - 7.3 pH); |
| alkaline | .. | (7.4 pH or more). |

8. Natural soil drainage:

| | | |
|---|---|---|
| Well drained | .. | (well oxidized and free from mottling of colours in surface and subsoil); |
| moderately well drained | .. | (Well oxidized and free from mottling except in lower part of sub-soil); |
| imperfectly drained or somewhat poorly drained | | (Well oxidized surface, sub-soil mottled); |
| poorly drained | .. | (Gray colour, mottling in surface and subsoil); |
| very poorly drained | | (dark surface soil and gray or mottled subsoil). |

| | | | |
|---|---|---|---|
| 9. | Inherent fertility | .. | High; moderate; low; very low. |
| 10. | Organic content | ,, | High; medium; low. |
| 11. | Slope | .. | Nearly level;<br>gently sloping;<br>moderately sloping;<br>strongly sloping;<br>steep;<br>very steep. |
| 12. | Erosion | .. | No apparent or slight;<br>moderate;<br>severe;<br>very severe;<br>very severely gullied land. |
| 12. | Wetness | .. | Slightly wet (growth of crops slightly affected or planting dates delayed for brief periods, as less than a week);<br>moderately wet (growth of crops moderately affected or planting dates delayed by a week or so);<br>very wet (growth of crops seriously affected, or planting delayed as much as a month or more);<br>extremely wet (swamp, marsh, too wet for cultivated crops or improved pastures). |
| 12. | Salinity | .. | Slight (crop yields slightly affected or range of crops slightly limited);<br>moderate (crop yields moderately affected, or range of crops moderately limited);<br>severe (crop yields seriously affected, or range of crops severely restricted);<br>very severe (growth of useful vegetation prohibited except some salt-tolerant forms). |

13. Frequency of overflow .. Occasional overflows, or overflows of short duration (crops occasionally damaged, or planting dates delayed);

frequent damaging overflows, or overflows of long duration (crops frequently damaged, or range of crops limited);

very frequent overflows, or overflows of very long duration (not feasible for cultivated crops).

With these facts and a knowledge of the climate of the area, the land can be classified according to its capability - its ability to produce permanently under specified uses and treatments.

For each area, one or more soil conservationists, combining the techniques of soil science, plant technology, engineering, and biology, and working with local farmers together determine how the land should be used and the practices needed for each kind of land. The facts recorded on the land map, research findings, and all technical information are joined with practical farm experience in classifying the land and in working out the right combination of practices to make full use, without waste, of the land resources.

2. The classification scheme:

The land-capability classification is a systematic arrangement of different kinds of land according to those properties that determine the ability of the land to produce on a virtually permanent basis. Suitability for cultivation is assumed to include the use of machinery - at least of plows, tillage implements, and harvesting

equipment - and the capacity for at least a moderate yield of one or more crops with suitable treatment and protective measures. The restrictions imposed by natural land characteristics necessarily affects (a) the number and complexity of the corrective practices to be used; (b) the productivity of the land; and (c) the intensity and manner of land use - for example, the choice of crops on cropland or the amount and season of use on grazing land.

The classification is made and used for practical purposes, which is the selection and application of land uses and treatments that will, while using the land, keep it in condition for longtime production. The latter will involve control of erosion, conservation of rainfall, and maintenance.

The classification is arranged according to a number of categories.

The first category covers land suited for cultivation and land not suited for cultivation.

The second category covers the eight land-capability classes. Four are suited for cultivation and four are not. The classes under this category are differentiated according to the degree of limitations in land use imposed by the nature of the land itself.

The eight land-capability classes range from the best and most easily farmed land (class I) to land which has no value for cultivation, grazing, or forestry, but may be suited for wildlife, recreation, or for watershed protection (class VIII). They all fall into the two broad groups of land, one suited for cultivation, the other not suited for cultivation.

Classes I, II and III include land suited for regular cultivation. Class I land is very good nearly level land, with deep, easily worked soils that can be cultivated safely with ordinary good farming methods. Class II land is good but it has some limitations. It needs moderately intensive treatment if it is to be cultivated safely. Such treatment, for example, may be contouring and cover cropping to control erosion, or simple water-management operations to conserve rainfall. Class III land is moderately good and can be used for cultivated crops regularly in a good rotation, if plowed on the contour on sloping fields. It has limitations of such degree that intensive treatment is necessary. The treatment may be terracing or strip-cropping to control erosion, or intensive water management on flat, wet areas.

Class IV is fairly good land, but its safe cropping use is very limited by natural features such as slope, erosion, adverse soil characteristics, or adverse climate. As a rule its best use is for pasture or hay, but some of it may be cultivated occasionally with proper safeguards.

Classes V, VI and VII are not suited for any cultivation but may be used for grazing or forestry, according to adaptability. Class V land has few natural limitations for such uses, and needs only good management. Class VI needs protective measures, usually because of slope or shallow soil. Class VII needs extreme care to overcome or cope with its major limitations, which usually are steep slope, very shallow soil, or other very unfavourable features.

Class VIII land is suited for wildlife, recreation, or watershed protection. It is usually characterized by such features as extreme steepness, roughness, stoniness, wetness, sandiness, or erodibility. These characteristics

make it unfit for any safe or economical cultivation, grazing, or forestry.

An outline of the land-capability classification is shown in table 1.

The eight land-capability classes cover a simple land classification useful for many purposes. They are not detailed enough, however, for many specific recommendations about management and treatment of land. These eight classes are distinguished from each other by inherent, durable land characteristics. Each of the eight classes is determined by the degree to which the land characteristics represent longtime limitations on land use. Each land-capability class includes a specified range in degree of its natural limitations with respect to use.

The subclasses represent convenient groupings of subordinate characteristics. A land-capability class is determined by the degree of limitations in land use, together with the hazards involved. Within a given land-capability class the subclasses are determined by the kind of limitation. For example, within class III land, suited for cultivation but subject to severe hazards, most frequently we have sloping land subject to water erosion, but we also have smooth land subject to wind erosion and wet land that produces crops only if drains are installed and maintained.

Within each subclass the land that is suited for essentially the same kind of management and the same kind of conservation treatment is designated as a land-capability unit. A land-capability unit is essentially uniform in all major characteristics that affect its management and conservation. It is the smallest unit recognized

Table 9-1: Outline of the land-capability classification

| Land use suitability (broad grouping | Land-capability class (degree of limitations for use) | Land capability subclass (grouped according to kind of limitation; shows examples only) | Land-capability unit (land-management groups based on physical characteristics; shows examples only) |
|---|---|---|---|
| Suited for cultivation | I. Few limitations. Wide latitude for use. Very good land. (Green on coloured map)<br>II. Moderate limitations in use. Good land (Yellow)<br>III. Severe limitations in use. Regular cultivation possible if hazards are provided against. Moderately good land. (Red).<br>IV. Very severe limitations in use. Suited for occasional cultivation or for some kind of limited cultivation. (Blue) | e Use is limited by moderate hazards of water or wind erosion.<br>c Climate.<br>w Use is limited by excess water; drainage needed for cultivation.<br>s Use is limited by low water-holding capacity or by low plant-nutrient content. | Moderately sloping, slightly acid soils on limestone.<br>Moderately sloping, highly acid soils on sandstone or shale.<br>Imperfectly drained acid soils.<br>Poorly drained neutral soils.<br>Sandy, rapidly permeable soils. |
| Not suited for cultivation. | V. Not suited for cultivation because of wetness, stoniness, overflows, etc. Few limitations on use for grazing or forestry. (Dark green)<br>VI. Too steep, stony, dry, wet, etc., for cultivation. Moderate limitations on use for grazing or forestry (Orange)<br>VII. Very steep, rough, dry, wet, etc. Severe limitations on use for grazing or forestry (Brown).<br>VIII. Extremely rough, dry, swampy, etc. Not suited for cultivation, grazing, or [illegible] | Grouping of sites according to kind of limitation. | Sites significant in management of ranges, pastures, forests, etc. |

in the land-capability classification, although greater detail may be recognized for some local purposes in mapping.

Table 1 shows the relation of the different categories to each other. It gives the eight land-capability classes and examples of the subclasses and units.

The eight land-capability classes are indicated on maps by Roman numerals I to VIII, or by standard colors, or by both. The Roman numerals and the standard colours are uniform on a nationwide basis. Sub-classes are designated by lowercase letters, and land-capability units by ordinary numerals, as IIel and IIe2.

The eight land classes express degree of usefulness. The subclasses express kinds of limitations within each class; and the units, divisions of the subclasses, are practical groupings for use and treatment of the land.

The four subclasses, which may be recognized in most of the land-capability classes, except class I, are:

- e. Land dominantly subject to wind or water erosion, or both.
- w. Land subject to presence of excess wetness or to overflow.
- s. Land limited chiefly by soil conditions, such as excessive sandy texture, excess of gravel or stones, or shallow depth.
- c. Land limited chiefly by climate, either inadequate precipitation or low temperature.

Land-capability maps show the eight land-capability classes in colours and the physical land factors of soil, slope, and erosion by boundary lines and symbols. Class I land is shown in green, class II in yellow, class III in red, class IV in blue, class V in dark green, class VI

in orange, class VII in brown, and class VIII in purple on coloured maps.

3. <u>Land suited for cultivation</u>:

<u>Class I land</u>: Class I is very good land that can be cultivated safely with ordinary good farming methods. It is nearly level land, has deep, productive, easily worked soils, and is not subject to more than slight water or wind erosion. It is well drained and is not subject to damaging over-flows. It is suited for intensive cropping, such as production of corn and other intertilled crops.

Class I land may be recognized under irrigation where under natural conditions it was essentially valueless for crop production. Class I irrigated land ordinarily has a slope of less than 1 per cent and a deep, medium-textured moderately permeable soil of good water-holding capacity. Some class I irrigated land requires initial conditioning, such as levelling to the desired grade, leaching to remove salts, or the lowering of a seasonal water table. If limitations are likely to recur and require periodic attention, however, the land is subject to continuing limitations in use, and is not class I. Class I land may also be recognized in artificially drained areas where the soil is moderately to rapidly permeable. On certain lands that meet the ordinary requirements for class I, drainage is sometimes worthwhile as a practical method for greater production or ease of operation.

Class I land for crop use may, in some places, require the use of fertilizers and lime, cover and green-manure crops, crop residues, and crop rotations.

Class II land: Class II is good land that can be cultivated with easily applied special practices. Some of its variations are: gentle slopes, moderate susceptibility to erosion, soils of only moderate depth, occasional moderate overflow, and moderate wetness easily correctible. These are examples - the list is not complete. Each of these limitations requires attention on the part of the land operator. The limitation sometimes gives the farmer less latitude in choice of crops or of management methods or requires special practices such as soil-conserving rotations, water-control devices, and tillage methods, to name only a few.

Generally its safe use calls for a combination of mutually supporting practices. For example, the class II gently sloping land having deep soils subject to moderate erosion needs several of the following practices: Terracing, stripcropping, contour tillage, crop rotations that include grasses or legumes, vegetated water-disposal areas, cover or green-manure crops, stubble mulching, fertilizers, manure, and lime. The exact combination of measures will differ from place to place. It depends on the characteristics of the land, including climate, and the system of farming the farmer wants to follow.

Class III land: Class III is moderately good land that can be used regularly for crops in a good rotation, with intensive treatment. Some of the characteristics of this kind of land are: Moderately steep slope, high susceptibility to erosion, moderate overflow, slow or very slow subsoil permeability, excessive wetness, shallow depth to bedrock, hardpan, or clay-pan, sandy, very sandy, or gravelly soil with low moisture capacity, and low inherent fertility.

Class III land is more limited in use by its natural characteristics than class II land. Limitations of some Class III land restrict the choice of crops or the timing of such operations as planting and tillage. An adequate soil-conserving rotation includes enough ground cover to reduce losses of soil through erosion, minimize losses of plant nutrients through leaching, maintain good soil structure so that it will absorb water readily, increase and maintain organic matter and nitrogen supply of the soil, and promote high yields of cultivated crops grown in the rotation. On moderately steep slopes of some class III land, the rotations should be longer than on level land and must include more years of hay or other sod crops to prevent excessive soil losses.

On much of the nearly level wet land of this class, having heavy, slowly permeable soil, a drainage system along with a cropping plan including deep-rooted legumes grown in rotation is needed. To maintain good soil structure and prevent puddling and resultant reduced permeability on such soils, it usually is necessary, also, to supply organic matter and to be careful not to work the soil when it is too wet or too dry. Class III land in some irrigated areas is limited in use by a high water table, slow permeability, and danger of salt accumulations.

On class III land that is subject to wind erosion, the practices for controlling this type of erosion are the same as those recommended for class II land - contour farming, stripcropping, stubble mulching, rough tillage, and terracing where it can be used effectively.

<u>Class IV land</u>: Class IV is fairly good land that is best maintained in perennial vegetation but can be cultivated

occasionally or in a limited way if handled with great care. Its cropping use is restricted by natural features, such as slope, erosion, unfavourable soil characteristics, or adverse climate. Much class IV land in the humid regions is suited for occasional cultivation. On it the farmer can safely use a long rotation such as a grain crop every 5 or 6 years, followed by several years of hay or pasture. Some of the nearly level imperfectly drained land classified as IV is not subject to erosion but is unsuited for intertilled crops because of the time required for the soil to dry out in the spring and because of its low productivity when in these crops. Also choice of crops is often limited. Some class IV land is suited only for certain specialized crops.

In subhumid regions some of the land classified as IV is shallow or only moderately deep, moderately or strongly sloping, low in fertility, extremely sandy, or sometimes moderately saline. Longtime rotations including soil-building legumes and grasses are in some places difficult to follow in a semiarid climate. Periods of weather suitable for getting a stand of grasses or legumes occur at irregular intervals. Whenever a stand is obtained the land should remain in these protective crops at least long enough to restore soil structure and fertility.

In some semiarid regions, on the other hand, the best land is in class IV. All cultivation is subject to very severe limitations because of wind erosion. Special and intensively applied cropping systems and practices are needed during the time of cultivation to conserve soil moisture and reduce erosion.

Class IV semiarid land often produces high yields of adaptable crops during years of above-average rainfall. But

during years of average or below average rainfall it produces low yields. During bad years the land must the protected from blowing. It needs special treatments, special cropping systems, or special practices to protect it against erosion and to conserve moisture. These treatments must be applied with greater regularity in dry years. Sometimes protective crops must be planted primarily to hold the soil. Perennial vegetation is needed to protect the land during severe drought and to rebuild soil structure and fertility.

Most of the class IV land in humid regions is well suited for woodland. Unless needed for pasture, it is not as a rule desirable to clear areas now covered with trees.

4. Land not suited for cultivation:

Class V land: Class V is land not suited for cultivation but is suited for perennial vegetation (grazing and forestry) with few or no limitations. Cultivation is not feasible because of one or more factors, such as wetness, stoniness, or some other limitation. The land is nearly level and not subject to more than slight wind or water erosion. Grazing use or forestry use is governed by the requirements for a good cover of vegetation. Certain range-management or woodland-management practices, such as stocking within the range's carrying capacity and the control of burning, are always needed for satisfactory production. Class V land on which vegetation has become temporarily depleted through misuse may require moderate or even severe restrictions in grazing or woodland use for a period, in order to improve the vegetation. The land, however, is not damaged easily.

Class V also occurs in many of the swampy areas that cannot be drained feasibly.

Class VI land: Class VI is land subject to moderate limitations under grazing or forestry use. It is too steep, subject to erosion, shallow, wet, dry, or otherwise not suited to cultivation, but with careful management is suited to either grazing or forestry. Some class VI land can be tilled just enough to establish pastures; some can be used safely for tree crops. The restrictions commonly needed on class VI range land are chiefly adjustment of grazing to the carrying capacity, deferred grazing to permit growth of grass in the spring, and rotation of grazing to permit the grass to recover enough to form seed. Fencing, careful location of watering places, salting, and herding are some of the practices necessary to use the land properly. Gullies should be controlled by diversion of water, planting, or other adaptable measures. Contour furrows, ridges, diversions, or water spreaders are useful on some sites to store in the soil more of the runoff by checking or diverting the water.

Land of class VI is capable of producing forage or woodland products under moderate restrictions. If the vegetation has been depleted by mismanagement, severe restrictions in use for a few years probably are needed to permit recovery of vegetation. An example of such temporary severe restrictions would be exclusion of livestock from overgrazed class VI rangeland until desirable vegetation is restored.

Pastures in humid regions on class VI land generally need liberal fertilization and careful adjusting of grazing. Many of them need liming and reseeding.

Class VII land: Class VII is land that is subject to severe limitations or severe hazards under either grazing or forestry use; it is not suited for cultivation. It is very steep, eroded, stony, rough, shallow, dry, swampy, or otherwise unfavourable, but can be used for grazing or forestry

if carefully handled. Owing to these adverse land characteristics that severely limit the growth or utilization of vegetation, the land is generally only fair or poor for grazing or forestry. Depletion of cover on rough, erodible class VII land leads to more rapid damage than on class VI land that has similar but less extreme limitations. Structures such as contour furrows, ridges, and water spreaders for the most part cannot be used on class VII rangeland because of steep slopes, shallow soils, or other unfavourable factors.

Most class VII land in humid regions is recommended for woodland rather than for pasture. Practices recommended for woodland usually include exclusion of livestock, prevention of fire, selection of trees for cutting, and careful harvesting methods. Most of the severely gullied land in humid areas consists of class VII that should be planted to trees.

5. <u>Land not suited for cultivation, grazing or woodland</u>:

<u>Class VIII land</u>: Class VIII is land of such unfavourable characteristics as to be unsuited for cultivation, grazing, or forestry. It is suited for wildlife, recreation, or watershed-protection uses. It includes such areas as marshes, deserts, badlands, deep gullies of the caving type, high mountain land, and very steep, rough, stony, barren land. Class VIII land often occurs in small areas, such as roadsides or ditchbanks, that cannot be shown on the maps made for farm-conservation planning. Protection is necessary even for some of these areas.

## B. Terracing as a Means to Conserve Land

As a means of controlling erosion and conserving rainfall on sloping land, farmers long ago introduced the use of hillside ditches. The ditches themselves proved inadequate, but the principle of controlling erosion by systematically intercepting surface runoff on sloping lands has led to the use of farm terracing. The development of terracing as recommended today has required years of use, extensive field observations and experimentation, and many modifications from time to time in construction procedure. When terraces are properly used and constructed and adequately supported by approved cropping and tillage practices they provide one of the most effective erosion-control measures applicable to cultivated lands. When improperly constructed or not coordinated with good land use and soil-conserving practices, they often accelerate rather than retard soil losses.

This section gives up-to-date information on terrace construction and maintenance in coordination with other recommended soil conservation practices. The information it contains is based on the terracing work of the Soil Conservation Service in every important agricultural region of the United States.

The basic factor that must be recognized in the application of erosion-control measures is the proper utilization of the land. The use of land in accordance with its capabilities is a guide in considering what areas or fields are to be terraced and what areas need a combination of terracing and other supporting measures. Land used for cultivated crops should be terraced where runoff and erosion cannot be controlled by use of vegetation or tillage practices in the proposed cropping rotation or with contour stripcropping.

Land unsuited for cultivated crops should not be terraced except in special cases. For instance, where land has been severely impoverished, terraces may be desirable to assist in the establishment of a permanent stand of grass. In such places terraces are used as a temporary measure and may be constructed according to standards somewhat below those required for a permanent system. Experience indicates that terracing on land not suited to cultivation usually results in expensive failures. The original cost and subsequent maintenance are high, owing to steep slopes, erosion, or unsatisfactory working conditions of the soil. The high cost of construction and maintenance coupled with the unusually low yields in cultivated crops would indicate that a less intensive use, such as for pasture, meadow, or woods, would result in greater net income.

The success of terracing depends primarily on maintenance and management. Neglect of the terrace system will destroy the terraces and cause serious erosion in the field. In keeping terraces in repair, the most important operation is proper plowing.

Plowing should be parallel to the terraces. Plowing across terraces, up and down the slope, fills the channels and destroys the ridges. Plowing parallel to the terrace, so that a dead furrow falls in the channel and a backfurrow on the ridge, keeps the channel open and builds up the ridge. In this way, well-built terraces can be kept to proper size, and terraces slightly undersize can gradually be built up.

If terraced fields are plowed as they should be, terrace maintenance becomes a part of the regular tillage operations and not a special maintenance job.

Old terraces that have been well maintained seldom need repair, but new ones may require some attention during

the first few years. Fresh fills in the ridge may have settled unevenly, and the low spots thus formed should be built up. This work can best be done before plowing so that the repaired spot will be smoothed up in plowing and harrowing.

1. <u>Terracing and agronomic control measures</u>:

Terracing cannot be economically justified on cropland that can be protected by less expensive conservation measures. Agronomic measures such as contour tillage, crop rotations, and stripcropping, are all that is needed on many sloping areas. These agronomic measures alone may furnish enough protection where rainfall intensities are low and the soil absorbs the rainfall rapidly, where the soils are erosion resistant and the slopes gentle, and where profitable rotations can be introduced that will provide an erosion-resistant cover during a large part of the rotation cycle, particularly during the rainy seasons. But where erodible soil, long slopes, and high rainfall intensities prevail and where short rotations must be followed to provide a profitable farm income, the agronomic control measures may give only partial control. They can then be reinforced with terracing.

Terraces should always be supplemented with the best possible cropping practices because terraces in themselves do not improve soil fertility and used alone they fail to hold the soil adequately. These facts justify the expectation that terraced fields properly supplemented with other practices will produce better crop yields over several years than unterraced fields.

2. <u>Hydraulics of terrace design</u>:

Rainfall coming at a high rate is likely to induce considerable surface runoff, which will cause erosion down

the slopes. When runoff attains a velocity of about 2 to 3 or more feet per second it is usually capable of loosening and transporting topsoil from unprotected fields, especially where raindrop splash has aided in throwing soil particles into suspension. Velocities of even less than this frequently cause erosion on some of the finer clays and sands. At the top of a slope the quantity of runoff is usually small and the movement slow - without power to do much damage. But as the water flows down the slope its volume and velocity tend to increase, and it gains increasing momentum and power to tear way soil particles.

Terraces must intercept the surface runoff before it attains sufficient velocity to severely erode the soil. They must carry the surplus rainfall from the field at non-erosive velocities and deliver it to stabilized water-ways where gullies are not likely to be formed by the discharge water. This is accomplished by placing a series of terraces across the slope, the first one being located near enough to the drainage divide to intercept all the runoff from that part of the contributing areas above before it attains excessive erosive power or a volume that will exceed the capacity of the terrace channel. Each succeeding terrace downslope is located in a similar manner. The surface slope, the rate of velocity of runoff, and the amount of rainfall within a given period are therefore the first factors to be considered in the design of a terrace system.

Ordinarily a terrace is designed to take care of runoff from rains of the maximum intensity that is likely to occur during a 5 to 10 year period. Designing for runoff from rains of the maximum intensity likely to occur during a shorter period would result in frequent overtopping and consequent heavy repair costs, and designing for runoff from rains of an intensity that is not likely to occur more frequently than once in 15 or 25 years might involve excessive construction costs.

The velocities in terrace channels: Terrace channels of ample capacity must be constructed so as to transport water at nonerosive velocities; otherwise much soil may be carried from the channel with the runoff and serious gullying may develop. The velocity in a terrace channel increases not only as the slope of the channel increases, but as the average water depth (approximately the hydraulic radius) increases and as the surface resistance (coefficient of roughness) decreases.

Under field conditions, the roughness of the channel surface is established by soil, tillage and crop conditions and cannot be changed to control velocity. The velocity, therefore, can be controlled by adjusting only the gradient and the average depth of water in the channel.

The maximum channel gradient that can be satisfactorily used must be less than the minimum slope that produces sufficient channel scouring to injure the terrace. The average depth of flow can be adjusted and the capacity maintained by changing the shape of the cross section of the channel. If other factors remain constant, a narrow, deep channel will produce a higher velocity with greater erosive power than a wide, shallow channel because the average depth of flow is less than the shallow channel.

In terrace construction, a channel of uniform cross section is desirable. In order that such a channel may take care of the increasing amounts of water being intercepted the gradient is increased along successive segments of the channel. The final gradient will be limited by the maximum permissible velocity above which scouring will result. Thus, by proportioning the channel area, shape, and slope the necessary channel velocity and capacity can be obtained.

3. Types of terraces:

The ultimate objective of all terraces is soil conservation. This objective is achieved by terraces that

provide for the interception and diversion of runoff or the impounding of surface runoff for increased absorption. From a functional aspect, terraces are classified as (1) interception and diversion types and (2) absorption types.

When the construction characteristics are considered, it is found that a well-constructed channel somewhat below the original ground surface is the most dependable structure for intercepting and diverting runoff, whereas a ridge constructed well above the original ground surface, with as little channel as possible, is the best structure for impounding runoff for increased absorption over a wide area above the ridge. Generally terraces are classified as (1) the broad-channel type; (2) the ridge type; and (3) the bench terrace, which is sometimes used on steeper slopes.

In some sections both absorption and diversion are important objectives of terracing, but there are large areas where diversion is of first importance and other areas where absorption is.

Regions of moderate rainfall and favourable soil conditions will have intermediate terrace requirements, and a dual-purpose terrace combining the desired features of both types can be used. Cross-sectional dimensions of all terrace types will differ throughout the country according to the soil, terrain, rainfall characteristics, and types of machinery to be worked over them. But the fact that dimensions must be adjusted to meet local conditions does not invalidate the classification of all terraces according to function.

Broad-channel terraces: The broad-channel terrace acts primarily to conduct excess rainfall from the fields at non-erosive velocities. Since low-velocity surface removal of

excess rainfall is required, the channel and not the ridge is of primary importance. A wide, relatively shallow channel of low gradient that has gentle side slopes and ample water capacity will give the most desirable results.

The excavated earth is used to bring the lower side of the channel to a height sufficient to provide necessary capacity. A high ridge is not desirable since it seriously interferes with tillage operations, increases construction costs, and frequently requires for its formation a large part of the topsoil scraped from the field. In the broad-channel terrace the ridge should be considered as supplemental to the channel and should blend gradually into the surface slopes to afford a minimum of interference with machinery operations. Moreover, the low gradient of the downslope side of the ridge, which is the critical part of of ridge terraces, so nearly conforms with the natural slope of the land that there is much less danger of erosion at this point.

Ridge terraces: Erosion control by the ridge terrace is accomplished indirectly by water conservation. In order to increase absorption the terrace is constructed so as to flood collected runoff over as wide an area as possible. If this is to be done most effectively the surface slopes on which the terraces are built should be fairly flat, the ridge should be of sufficient height to pond water over a relatively large surface, and the earth required for the ridge so excavated as to avoid concentration of runoff on a small area.

The degree to which these conditions can be attained is limited by necessary construction methods and the slope of the land. In this type of terrace the ridge is of greater importance than the excavated channel, which is more or less

incidental to the construction of the ridge. When maximum absorption is desired, the terraces must be designed for ample storage capacity and placed on level grades with closed ends. As a factor of safety the ends are often left open so that excess rainfall can escape before the terrace overtops. In some areas the ends of the terraces are partly blocked depending on the necessity of safety outlets for excessive rains not included in the design frequency. If the impounded water from level terraces would result in excessive crop damage, a slight channel grade, particularly near the outlet, may be necessary.

The ridge terraces are adapted to low rainfall areas and to soils that will absorb the accumulated runoff fast enough to prevent damage to growing crops. These areas are largely confined to absorptive soils and gentle slopes in wind-erosion areas. The ridge terrace may also be used with considerable success on certain areas of sandy soils and gentle slopes where the rainfall is heavier, such as sandy coastal plains. Thorough examination of the soil absorption and rainfall rates should always be made before this type of terrace is used.

Bench terraces: Bench terracing is one of the oldest mechanical methods of erosion control, having been used for many centuries in thickly populated countries where economic conditions necessitated the cultivation of steep slopes. Bench terracing was highly developed by the Inca civilization centuries ago in the Andes Mountains of Peru, in parts of China, the Mediterranean countries, and in other places. It consists principally in transforming relatively steep land - 20 to 50 percent slopes - into a series of level or nearly level strips, or steps, running across the slope. The strips are separated by almost vertical risers, which

are of rock or earth protected by a heavy growth of vegetation. This type of terrace exemplifies the original meaning of the word terrace.

The use of bench terraces on steep slopes not only retards erosion losses but it also makes cropping operations on these slopes possible and safe. Whenever the absence of adequate flatlands, or the special adaptability of particular slopes to high income crops necessitates the cultivation of steep slopes, the bench terrace will probably continue to be used.

When a bench terrace is constructed (by excavation) the tendency is to remove the fertile topsoil from the bench leaving subsoil exposed for the planting of crops. It usually takes 2 or 3 years to put the bench into shape for cultivation by the heavy use of commercial fertilizers, farm manure and green-manure crops. On deep soils, grass crops may be grown as soon as the benches are completed by using plenty of fertilizer or compost material. Many of the bench terraces of the Mediterranean countries are made of soil carried in from other places with human labour.

Excavated bench terraces should usually have a vertical interval between benches such that the area to be excavated will equal the area to be filled (fig. 9.1). If the slope or riser is of earth construction, it should be as steep as possible, $\frac{1}{2}$ foot horizontal to 1 foot vertical or steeper. If the riser is of rock it is built nearly vertical. The slope or riser, if not of masonry, should be planted to deep-rooted grass so as to hold it in place and prevent erosion. The bench or floor of the terrace should slope inwards from the toe to the heel about 1 inch per foot so that excess rainfall will flow towards the heel and be carried


FIG. 8.1 CROSS SECTION OF AN EXCAVATED BENCH TERRACE.

off in a small ditch. This small ditch should follow the heel to a grassed or forested area or to a protected ditch for safe disposal. These excavated terraces should be laid out and built so as to have a slight grade ($\frac{1}{4}$ of 1 per cent, longitudinally) so that the water carried across the bench of the heel will be carried away to the disposal ditch or area.

These water-disposal outlets may be constructed of masonry, wood, or some such material, if additional protection is needed due to the high velocity of the water. If the slope is not too steep, and the disposal ditch can be widened, the area can be stabilized by the planting of certain grasses, legumes, or certain types of vines.

Excavated bench terraces may be built with handtools or, if the slope is not too steep, with power equipment. Bench terraces are not recommended on slopes below 15 per cent. The cost of constructing bench terraces is excessive. As a general rule their use is not recommended.

A much more satisfactory procedure is to develop bench terraces rather than to "excavate" them. In bench formation, the land is used for normal hillside farming while the benches are forming. The method found most satisfactory is to plough the land on the contour and allow the soil to move downhill against a barrier of still-stemmed grasses until the slope has been reduced to a nonerosive grade.

A barrier of stiff-stemmed grass, such as Merker (Pennisetum purpureum var. merkeri), is first planted on the contour at vertical intervals recommended for the various slopes. Then the land between the grass barriers is

used in the normal manner, but care is taken to plow towards the barrier line each time the land is plowed in the preparation of a seedbed for a new planting. The slope of the bench will change with each plowing and after about seven or eight plowings a very satisfactory bench will usually be formed. The land would not be out of use at any time as it would be where terraces are constructed outright. Also, soil loss will be reduced by the use of the barriers and contour cultivation. This is sometimes referred to as the California or Puerto Rico terrace. In using this method the objective is to allow normal movement of soil, by erosion and gravity, between the vegetative barriers, but to stop and hold this soil at the barrier lines.

Benches can be developed on slopes up to about 45 per cent where the soil is fairly deep. A vertical interval of 6 feet is considered satisfactory. This interval may be somewhat increased if the soil does not wash badly during the earlier stages of bench formation and will stand a riser of more than 6 feet high with a back slope of ½ to 1 or 1 to 1. A flatter back slope can only be used at the expense of the bench.

No provision is made for carrying off water along the heel of the developed terrace as a continuous grade cannot be maintained longitudinally along the terrace by plowing under normal farming operations. In some places the plow will dig deep on account of a soft spot while in others the plow will ride over obstructions such as rocks, roots, and hard spots. Unless the slope is extremely long the water is allowed to move down the slope through the barrier grass. Intercepting ditches draining to protected disposal ditches or areas should be used below the barriers where the length of slope might cause a concentration of

Merker grass seems to be the best grass to use for the barriers; however, any stiff-stemmed grass may be used provided it does not seed in such a manner as to become a pest on the bench devoted to clean-tilled crops. A mixture of Melao (Melinis Minutiflora), or of Jaragua, and Tropical Kudzu (Pueraria Phaseoloides) has been highly successful in Puerto Rico. When this mixture is used as a barrier it also covers the riser. It is an excellent feed for farm animals.

During the development of terraces the barrier grasses should be kept harvested, especially if Merker is used. It makes good fodder for cattle and under normal conditions of rainfall it can be harvested every 3 months. Merker grass in a barrier should not be cut lower than 10 inches to 18 inches from the ground. By cutting it at that height a better barrier is formed and there is no tendency for the grass to spread out over the bench. The banks or risers of the formed terraces are protected by the barrier grass or by allowing native vegetation to come in naturally.

Before the use of bench terraces in any area is considered, a thorough study should be made to determine whether there is justification for cropping the steep slopes that require this type of protection. If suitable lands with flatter slopes are available or if a profitable return cannot be expected, cropping of the steeper slopes by the use of bench terraces should be discouraged. The construction of bench terraces on flatter slopes that are suitable for the ridge or channel terrace should also be discouraged.

4. Planning the terrace system:

Certain fundamental engineering principles are involved in designing and constructing terraces, but a high degree of theoretical training is not so important as the

faculty of good judgment, combined with an agricultural background and a general understanding of the various phases and measures of erosion control. It will usually be well for farmers who have not had training in the use of surveying equipment and in the planning of a terracing system to have the surveying and planning done by an agricultural engineer or someone who has had the necessary training and experience.

In the preliminary planning, all necessary terracing for the entire farm should be considered in order that terracing on any part of the farm may be fitted into the complete terrace system without difficulty or unnecessary expense. The possibility of rearrangement of fields, fences, and roads to conform to good land-utilization and farm-management policies should be kept in mind. Terracing is usually planned according to drainage units, that is, areas that can be satisfactorily handled through one outlet or system of outlets. Such factors as ridges, drains, roads, large gullies, abrupt changes in slopes, property or field lines, and terrace lengths are some of the main determinants of boundary or division lines between terracing units.

Terrace outlets: The first step in planning the terrace system is to select the location for the outlet or disposal area. If protected areas or stabilized channels are not available, they must be provided before the terraces are constructed. Adequate outlets can usually be provided by protecting natural depressions with a cover of vegetation that will withstand the force of water moving down them. In some cases constructed channels will be necessary because of the absence of natural outlets or because gullying or other erosion damage has made the use of natural locations impracticable. Constructed channels may be protected with

vegetation if suitable varieties can be established. If adaptable vegetation is not sufficient for protection, mechanical structures will be necessary as a safeguard against erosion in the channel.

Owing to the hydraulic problems involves in estimating the amount of runoff, in designing the channels, and in determining the ability of various types of vegetation to withstand expected velocity, assistance should be secured from an engineer trained in the solution of such problems before constructing channels for outlets.

Vegetated outlets should be prepared one or two seasons in advance of terrace construction, depending on the length of time required to establish the necessary cover. Terraces should not be constructed before stabilized outlets are available to receive the discharge of excess runoff.

A meadow-strip outlet is a relatively flat swale that can be protected with adaptable grasses or legumes in an area large enough to form an economical pasture or hay unit stable enough to take care of excess runoff. The shape of the cross section must be such as to insure a wide shallow flow rather than a deep narrow stream whose velocities would be destructive. To prevent overflow and gullying along the edges, the vegetation should extend several feet beyond the edge of any expected flow of water. In order to maintain nonerosive velocities low gradients are required. Grades of less than 6 per cent have usually proved satisfactory. On erosive soils, however, a 6 per cent grade may be too steep for safety. Although a shallow, wide cross section is desirable, there must be sufficient fall from the terrace ends to the flow line of the outlet to prevent silting,

either in the channel or in the ends of the terrace. About 1-foot minimum fall is usually adequate for the narrower outlets, and a 1-foot fall in 50 feet of horizontal distance should be enough for wider outlets.

Constructed or artificial channels may be protected with vegetation if the expected water velocity is sufficiently low. The ability of different types of vegetation to withstand water velocity varies widely. A dense turf of bermudagrass has in numerous locations carried velocities of 8 to 10 feet per second without noticeable damage, and a well-rooted mat of kudzu vines will stand even higher velocities. Experience shows that bluegrass sod is limited to velocities of 5 to 7 feet, and most other adaptable grasses to somewhat smaller velocities. Annual and perennial lespedezas have a relatively low value for channel protection, being limited to velocities of 3 or 4 feet per second.

Locating the broad-channel terraces: The individual terraces on a field must be located so as to provide the necessary control of surface water, make farming operations as easy as possible, and perform satisfactorily with minimum maintenance requirements. There are a few general principles applicable to most conditions that will assist in attaining these objectives. Experience in locating terraces will be required, however, if the best job is to be done.

The capacity of the top terrace must not be overtaxed by runoff or the whole system will be endangered. This means that the top terrace must be placed at a point near the top of the slope where the drainage area above is no greater than the drainage area above any other terrace of equal length. A trial location of the top terrace should first be made and location then moved uphill if it is necessary to intercept surface flow above critical areas or to

place the terrace in better position with respect to the configuration of the field surface.

If short abrupt changes in slope occur, terraces should be just above rather than on or at the foot of them. Evidence of excessive erosion near the top of the field indicates that surface runoff has attained critical erosive velocities at that point and that the terrace should be moved higher up the slope. Minor adjustments should be made in the location of successive terraces in the field in accordance with these principles. Such adjustments should not exceed 15 to 20 per cent of the vertical interval of the terraces.

Sharp bends in the terrace retard the flow and cause silt deposits that may block the channel or interfere with cultivation of the field. Many bends may be smoothed out by adjusting the terrace location slightly. Occasionally a critical place in a field below the top terrace will necessitate locating a terrace at that point first. The terraces above should be located according to the determined spacing, but the last terrace must be sufficiently near the upper limits of the slope to be safe from overtopping.

A short terrace is much easier to maintain than a long one and requires less channel capacity. In order to decrease the length of drainage in one direction the terraces may be crested at points about midway between the outlets. The point of a ridge is an ideal location for the terrace crest and assures flow in both directions to the low points where outlets should be located. If possible, terraces should not be extended around the points of sharp ridges. If this must be done, the terraces should be strengthened at those points by increasing the height of the ridge and enlarging the channel.

Likewise, terraces should not be carried across depressions that collect considerable amounts of surface water, particularly if the terrace makes a sharp bend at this point. Although it is possible to enlarge the terrace sufficiently to carry the water that drains to such depressions safely, often the cost and labour involved will be excessive. Such places in a terrace require inspection and maintenance after each period of runoff owing to silt blocking the channel or excess water damaging the ridge.

In planning terraces it should be kept in mind that farm roads must be provided for access to all parts of the farm. Roads through a field should be located as nearly as practicable on the contour just below a terrace or on the crest of the terrace ridges. Vegetated outlets should not be used for farm roads, since farm vehicles would seriously damage the stabilizing turf in the channel bottom or create ruts that would be quickly enlarged by erosion unless expensive repair measures were undertaken promptly.

Locating the ridge terrace: Since level, ridge terraces are used to conserve moisture by impounding the water for increased absorption, there usually is limited need for outlets and in most instances they can be disregarded. On some of the steeper slopes, however, ridge terraces are used for the dual purpose of conserving water and controlling water erosion. Under these conditions outlets may be required and the entire problem of locating the individual terraces, determining the spacing, and controlling the discharge into outlets is handled in a manner similar to that described for the broad-channel terrace.

On more nearly level slopes under proper soil and climatic conditions these level terraces will not require outlets, although there may be occasional brief periods

when discharge will occur. On slopes of less than 3 per cent with smooth uniform surfaces, the terrace spacing should be regulated so as to impound all the runoff for the required rainfall intensity recurrence interval (usually the maximum rainfall intensity to be expected once in 10 years) and to provide for coverage by impounding water over as much of the field as practicable, with least interference of tillage operations. In deciding on the best spacing to use it is necessary first to determine the effective height to which the terraces will be constructed. The effective height will be the elevation of the blocks in the ends of the terraces above the natural ground level; usually the height of the blocks is from one-half to three-fourths the height of the terrace ridge. The capacity of the terrace will determine the maximum spacing.

Terracing and soils: Both terrace design and construction may be influenced to a considerable degree by the characteristics of the soils. For example, the erodibility or permeability of a particular soil may modify the selection of the terrace spacing, grade, and cross-sectional dimensions. Soil structure has a marked effect on construction features, such as size and type of equipment, difficulty of construction, season of construction, and time and power required, and the ease with which terraces can be constructed will be directly affected by soil characteristics. On some soils terrace construction may even be impracticable owing to the unstable nature of the soil or the presence of rock or hardpan near the surface.

5. Terrace specifications:

The previous discussion of slopes, rainfall and runoff rates, soil characteristics, vegetative cover, tillage, and cropping practices as related to terrace design

gives some appreciation of the many factors involved in establishing terracing specifications. It has not been found practicable to assign definite values to each of these variables and to treat each as a separate item in determining final terrace specifications. For such a procedure the problem is too complex and the variables too indefinite. Standard specifications can be established by using actual field and experimental data on terracing in a certain area as a guide for terrace design in similar areas.

Limiting land slopes: On slopes above 10 to 12 per cent, it is difficult to build and maintain terraces having adequate capacity that can be farmed with modern machinery. These steeper slopes are ordinarily not recommended for production of the more common clean-cultivated crops. In most agricultural areas the broad-channel terrace is applicable to the slopes, which under a good land use programme, are generally suited for the production of cultivated crops.

The upper limit of land slopes on which the ridge terrace can be used most effectively for water conservation is, in general, about 3 per cent. Where this terrace is used on lands having greater slopes the actual area ponded is too small to conserve much moisture unless the terrace ridge is built unreasonably high. If it is impracticable to obtain the desired storage capacity, a modified form of the ridge terrace may sometimes be used.

Where it is necessary to use slopes above 12 per cent for orchards and the production of farm crops, the bench terrace may be applied on slopes to around 25 per cent or a little more.

Spacings: A convenient rule that gives the approximate vertical interval (in feet) for average conditions can be determined by dividing the slope ( in per cent ) by 4 and adding 2 to the resulting quotient, $VI = (2 + S/4)$. To convert the result to metric units multiply by 0.0305, that is $VI = (2 + S/4)0.0305$ which gives the vertical interval in metres.

The minimum and maximum values differ from the average by 15 per cent. If exceptionally good cropping practices, erosion-resistant soil, and low rainfall intensities are characteristic of the area to be terraced, the terrace spacing might be increased as much as 15 per cent with reasonable safety. But if the rotations include a relatively high percentage of clean-tilled or row crops, if the soils are highly erodible, and if the rainfall intensities are high, terrace spacing should probably be decreased as much as 15 per cent.

It will often be found that a favourable factor is offset by an unfavourable one, and in such instances any deviation from recommended average spacings cannot be justified. For example, the value of a good erosion-resistant rotation may be offset by a very erodible soil or by high rainfall intensities so that the combined results are about the same as if all factors were average.

The ideal spacing for the ridge terrace would seem to be that which would give the most uniform moisture distribution and minimum soil movement between terraces as well as the least interference with tillage practices and a low construction cost. The water-storage capacity of a level terrace with closed ends is an important and often a limiting factor in determining spacings. It should be sufficient to take care of the maximum runoff accumulation

that can be expected from the contributing drainage area during the design period. This runoff may be as high as 4 or 5 inches in the semiarid regions and 7 or 8 inches in the more humid areas.

On fairly uniform slopes the average slope of the area can be used in computing the vertical interval for the terraces. If the slopes vary considerably the weighted average of all the slopes that a terrace is to cross should be used in computing the vertical terrace interval for each terrace.

Grades: Since experimental results show that both the rate of surface runoff and the soil loss in runoff increases with steeper terrace grades, the minimum grade that will provide satisfactory water discharge is desirable for the channel terrace.

In determining the final grade, the total length of the terrace should be estimated and a variable grade established that increases toward the outlet by regular increments. The grade is commonly changed every 300 to 500 feet. Wherever convenient, it is usually desirable to break grades at critical points such as gullies, fills, or low spots. Maximum grades of over 4 inches per 100 feet of length are seldom advisable since steeper channel grades usually allow excessive amounts of soil to be washed from the terrace channel. A possible exception may be found in areas with heavy clay soils or where runoff rates are relatively high. Under either of these conditions, a fall of as much as 5 inches per 100 feet of length for the last segment of a 1,600 or 1,800-feet terrace may be advisable.

The ridge terrace is built with a level grade. Whereever it is desirable to discharge some of the runoff either

one or both ends of the terrace can be left open.

<u>Lengths</u>: In general, 1,200 to 1,600 feet is the maximum distance that a terrace should carry water in one direction. Shorter terraces are desirable and should be used if convenient. The maximum length of the ridge or level terrace, particularly when both ends are left open or when a slight grade is used toward the outlet, should not exceed that recommended for the broad-channel type. This would mean that a maximum total length of 2,400 to 3,200 feet might be used for a level terrace if necessary.

<u>Cross sections</u>: The three main requirements of satisfactory terrace cross sections are:

i) Ample channel capacity;

ii) channel and ridge side slopes flat enough to permit the operation of farm machinery along the terrace without undue breaking down of the terrace or hindrance to tillage operations; and

iii) economical cost of terrace construction.

The broad-channel terrace provides channel capacity primarily by means of a graded, excavated waterway; the ridge terrace derives its capacity from a ridge that holds back the water in a way so as to flood a wide area. The water depth of a settled terrace of either type should be from 12 to 17 inches, and the minimum water cross-sectional area of the channel should seldom be less than 8 to 10 square feet. Larger cross-sectional water areas are usually necessary for the ridge terrace. Long terraces should have a larger cross-sectional area.

The side slopes of the channel or ridge should seldom be steeper than 4 to 1, and 5 to 1 is preferable. Steeper side slopes may be permissible where small equipment is generally used, but the flatter side slopes are

necessary for larger machinery. The total width of terraces may range from 15 to 40 feet, depending on the land slopes and the type of machinery to be provided for.

Terrace staking, realinement, and marking: The upper terrace is staked first, the drainage divide being used as a starting point from which to measure the vertical interval for the first terrace. An exception to this rule may be made if it is desired to have a definite location for some particular terrace in the system. This terrace would then be located first. After the upper terrace is staked, each of the succeeding terraces is staked in turn.

In order to get proper alinement of terraces at the outlet ditch it will usually be found most convenient to start staking at the outlet end of the terrace. The selected terrace-channel grades can then be used to locate all other stakes from there to the other end of the terrace. If the outlet ditch has terraces emptying into it from one side only, there is no particular advantage in starting to stake a terrace from the outlet end. Stakes should be set at 50-feet intervals except on curves and through draws, where a 25-feet spacing should be used. It is customary and usually most convenient to have the stakes indicate the location of the centerline of the ultimate terrace ridge.

6. Terrace construction:

Terraces may be constructed with light equipment adapted to the power available on the farm whether it be horses or mules or tractors, or they may be built with heavier, more expensive equipment especially designed for terracing. The cost on the one hand will be labour and time with little cash outlay, and on the other the cash outlay will be greater with a corresponding saving in time

and labour. A terrace not properly finished may do more harm than good; insufficient channel capacity will invite opertopping and failure; a narrow ridge will prevent the best use of tillage equipment and may contribute to inefficient use of the field.

In terracing a field the uppermost terrace should be constructed first, and after it, in turn, each succeeding terrace down the slope. If the lower terraces are constructed first they are likely to be badly damaged should a rain occur before the upper ones are completed.

Where terraces cross gullies or even slight depressions it is necessary to do some extra fill work in order to maintain the proper terrace locations and ridge elevation. A slip scraper, fresno, or rotary scraper is usually used for this work. Failure to build fills properly is a common cause of trouble in terracing.

A terrace cannot be considered completed until it has been carefully checked for correct grade and height. To assure proper channel capacity and the flow of water in the direction desired, low places on the ridge and high spots in the terrace channel should be marked and corrected before the equipment leaves the field. On the level terrace it is usually necessary to determine only the low points in the ridge. The level and rod are used in checking, and enough readings are taken to determine where corrections are necessary. Elevations and grades should be checked very carefully around bends and across gullies and at terrace outlets. A common fault in terrace construction is to provide too much grade near the terrace outlet. If much correctional work is required, it can usually be done most satisfactorily by using regular terracing equipment.

7. <u>Farming terraced land</u>:

The construction of a well designed system of terraces does not in itself stop erosion. Construction is only the beginning. The success of the terraces depends on whether they are properly maintained and farmed after construction. Too often erosion-control efforts cease with the construction of the terrace, and construction cost is wasted because of faulty cropping and tillage practices. A surprisingly large number of terraces that have been in use for 5 years or more are no longer effective because the continued practice of one-crop farming and tillage up and down the slopes have reduced the capacity of the terrace channels to such an extent that frequent overtopping has resulted.

One of the most desirable tillage practices for terraced land is contour farming - the plowing and planting of crops parallel to the terraces. This produces a series of miniature depressions and ridges between terraces, and these aid in moisture conservation and erosion control. Operating tillage equipment parallel to the terraces, particularly equipment that penetrates the soil, also results in minimum damage to the terrace ridge and channel. By plowing parallel to the terrace and regulating the location of dead furrows and backfurrows, terraces can be maintained and their cross sections changed so as to provide the most desirable slopes for any particular field.

In some areas stripcropping is combined with terracing to control erosion more completely. There are several methods of arranging the alternate strips of close-growing and row crops on a terraced field. The type of rotations, the crops, and the proportions of each crop to be produced will determine in part the arrangement and width of strips. In combining the two control measures (1) use

strips as nearly uniform in width as possible in order that rotation of crops may be practical, (2) have at least one boundary line of each strip fall between adjacent terraces so that a portion of each terrace interval will be protected by a close-growing crop, (3) eliminate point rows in so far as possible by absorbing irregular areas in strips of close-growing crops, and (4) use the minimum number of strips that will provide effective erosion control in order that the necessary tillage operations may not become unduly complicated.

Some farmers object to terracing because they believe that it will interfere with their regular farming operations. At the same time they usually fail to appreciate the fact that gullies that are gradually developing on their farms will eventually cause more serious interference with their farming operations than terracing possibly could and that the continual loss of topsoil will eventually make their entire farming operations futile. Farming terraced land is not unduly difficult if the farmer is willing to give up straight rows and try contour farming. Although contour farming introduces minor inconveniences it is usually found that the advantages far outweigh the disadvantages. Farmers have found that even the turning of equipment necessitated by short rows is not nearly as difficult as was anticipated. After the operator becomes accustomed to point rows he can carry on his regular farming operations with very little damage to crops. It has also been found much easier to operate machinery on the contour than up and down hill.

## C. Soil-Depleting, Soil-Conserving, and Soil-Building Crops

Some crops are said to be "soil-depleting", some "soil-conserving", and others "soil building". These crops differ in their effect on the land and on the conservation of soil and water.

The terms "soil-depleting", "soil-conserving", and "soil-building crops" must not be confused with soil-depleting, soil-conserving, and soil-building practices. A soil may be depleted by a bad practice although no crops are grown. Soil-conserving and soil-building practices involve the application of lime and fertilizers, the practice of rotations, and the use of other measures that go beyond the mere use of certain crops.

Plants need a variety of minerals for good nutrition, but the ones most commonly needed in general agriculture are lime, phosphorus, potash, and ocasionally magnesium. Under certain conditions elements such as manganese, boron, copper, iron, sulphur, and zinc may be added to soils to advantage. and in some cases, some of the less-common minerals. Plants also need nitrogen, but that does not come from the decomposed rock. A soil may be depleted with respect to its mineral plant food or with respect to its organic-matter content or both.

### 1. Soil-depleting crops:

A soil-depleting crop may be defined as one that causes rapid using-up of the organic matter and essential mineral constituents. The organic matter may be lost because the crop requires excessive cultivation. Minerals may be lost because the crop-leaves the oil exposed to erosion. The

term is a relative one; some crops are more soil-depleting than others. Small-grain crops allow some erosion and, whether harvested or not, are never true soil-conserving crops. There is, however, less soil depletion than where corn or cotton is grown.

If a small-grain crop is interplanted with clover or lespedeza and the legume covers the ground by the time the grain is harvested, probably as much organic matter will be left in the soil as is lost. There will be even more left in the soil if the grain is pastured down. A combination of a small-grain crop and clover or lespedeza pastured or left on the land tends to conserve the soil.

When all the lime, phosphorus, and potash has been taken from the soil in which plants grow, there is no other place the plant can get it. If these plants are grazed or otherwise removed from the soil on which they grow, just so much lime, phosphorus, potash, and other minerals as they contain are removed from the soil. If the plants are left to decay in place or are turned under, the minerals they contain are returned to the soil. The mineral content of soils may be depleted by cropping, by leaching, or by erosion; it may be conserved by proper farming practices that reduce leaching and erosion, but it cannot be increased by any form of cropping. When minerals are needed they must be added. All harvested crops remove something from the soil and in so far as this is done the soil is depleted. Cotton and corn are classed as soil-depleting crops; most hay crops as soil-conserving. A 4 ton per acre yield of alfalta removes more nutrients than 1 50-bushel per acre yield of corn, and a 100-bushel per acre çorn crop removes more nutrients than a 50-bushel per acre corn crop.

Cotton and corn are considered soil depleting because of the chance they give for erosion. If they could be grown under conditions that eliminate erosion, they would be no more soil depleting than hay.

The quantities of minerals removed by plants are small in comparison with those lost by erosion, but on the soils less well supplied with minerals the steady withdrawal of plant food through the years has a great effect and cannot be ignored. Old grass pastures become poorer with the lapse of time because the constant removal of herbage as milk and meat means the slow depletion of the soil. In addition to the nitrogen removed, with every 1,000 pounds of milk produced by cows on pasture, about 1.6 pounds of lime and 2 pounds of phosphoric acid are carried away. With every ton of alfalfa hay around 39 pounds of lime, 10.8 pounds of phosphoric acid, and 44.6 pounds of potash are removed; and the soil is depleted to that extent.

This depletion of the soil of minerals simply cannot be avoided if the crop is to be taken off the land. In the course of time these minerals will have to be replaced. If they are not replaced, a gradual decline in productivity may occur even without erosion. Fortunately, replacement of minerals is not very expensive and usually pays.

2. <u>Soil-conserving crops</u>:

Organic matter is essential to soil, and nitrogen, an important food element, is present in it. Soil-conserving and soil-building crops must be considered chiefly in terms of the effect these crops have on the organic matter in soils.

The destruction of organic matter is brought about by a process of oxidation through the action of micro-

organisms, aided by aeration of the soil following cultivation. The more intensive the cultivation, therefore, especially in warm sections, the greater the destruction of organic matter. Here soil erosion also plays a great part. The organic matter is mainly in the surface soil. It is this surface soil that is washed away, and the organic matter goes with it. Erosion too is facilitated by the stirring of the soil.

Crops that can be grown with a minimum of stirring the soil are in varying degrees soil-conserving crops. Non-cultivated crops, such as alfalfa, clover, lespedezas, kudzu, grass hay, and pasture, conserve the organic matter in the soil. The growing of these crops, therefore, tends to conserve the soil even if some minerals are carried away in the crops removed.

These close-growing crops prevent erosion with its attendant loss of organic matter and minerals. The annual stirring of the soil necessary to the culture of a small-grain crop occasions some loss of organic matter and allows more erosion than is permitted by meadow or pasture. A small-grain crop can be called a soil-conserving crop, therefore, only by comparison with a crop that is more soil depleting, such as corn or cotton. In comparison with meadow, small grain is a soil-depleting crop.

3. Soil-building crops:

Soil building crops must not only conserve the soil, but build it up - make the soil better. Plants cannot build up the minerals; all they contain comes from the soil. If plants are turned under, just so much goes back into the soil. If the soil needs more lime, phosphorus, or potash it must be added.

Plants can, however, build up the organic matter and with it the nitrogen content of the soil. Legumes, of course, work best as nitrogen gatherers. They get a large part of their nitrogen from the air, and if they are turned under, the soil will have that much more nitrogen.

The kind of legume used and the way it is used must be considered. Soybeans cultivated in rows and harvested as hay are about as competent soil robbers as corn. Even when the soybeans have been well inoculated there is more nitrogen in the soybean hay than the plant took from the air. Since the root system is relatively small, little nitrogen is returned to the soil. The same is true of other annual legumes, such as cowpeas and velvet-beans, if they are removed from the ground.

When these crops are broadcast or planted in close drills they help somewhat to stop erosion, but if harvested they do not build soil. That is possible only when they are turned under. Even when they are turned under, little benefit may be derived from the nitrogen unless another crop is ready to use it. Turning under a summer legume in the fall and leaving the ground bare is a wasteful practice. Most of the nitrogen derived from the legume is lost during winter by erosion or leaching. This is not the fault of the crop but of the practice.

All annual legumes have relatively poor root systems, usually not exceeding 10 to 12 per cent of the total weight of the plant. In redclover, on the other hand, about one-third of the total plant weight is underground. Even when a redclover crop is removed, organic matter and nitrogen remain to maintain soil productivity.

When soil-building crops are discussed, therefore, it is not enough to suggest the use of legumes. It is necessary

to specify not only the kind of legume, but also how it must be used to help in soil building.

The soil building commonly referred to in agricultural practice is a temporary process. It is quite true that when a green-manure crop is turned under, the soil is temporarily more productive than it would have been if that crop had not been turned under. This is due in part to the additional nitrogen supplied when a legume is turned under and in part to an increase in organic matter. If this organic matter were not later removed by cultivation the soil might be built up, but it is removed, at least in great part. The organic matter must be constantly renewed if the productivity of the soil is to be maintained. This is soil conserving rather than soil building.

For real soil building it is necessary to turn to permanent sod. A permanent sod will increase the organic matter in the soil, chiefly by its root growth. A healthy grass sod produces new roots every year, and the decay of the old roots adds to the organic matter, most of which is retained because the soil is undisturbed. These roots die and are renewed constantly and in a comparatively short time really build up the organic-matter content of the soil.

In a forested area, however, where the organic matter has been derived from fallen leaves and the decaying roots of trees and other vegetation, it takes a long time to build up the organic-matter content of the soil. Trees may build soil too slowly for man's immediate use.

A grass sod, if not utilized, is therefore probably the only practical 100 per cent soil-building cover. If it is grazed or if hay is taken off, it may be necessary to add plant food, but even then the protection from erosion

that such a cover offers, together with the increase in organic matter by root growth, makes such a crop the ideal for soil conservation. Of course all land cannot be treated in this way, and, in the main, crops should be called soil-conserving rather than soil-building.

## D. Pasture Improvement

Pastures afford one of the most effective and economical means of holding and enriching the soil, provided they are properly developed and managed. Two outstanding requirements of good management in humid sections where rainfall is usually adequate for abundant plant growth are (1) a sufficient supply of mineral plant foods such as lime, phosphorus, and potash for desirable pasture plants to make enough growth to cover and protect the soil and to provide forage for livestock, and (2) regulation of the number and kinds of livestock and the periods of grazing so that the pasture plants can make a vigorous growth during the grazing season.

When sloping land is kept in good pasture the wastage of soil is stopped. In addition, the soil under a good pasture sod actually becomes more productive when supplied with needed mineral plant food. About three-fourths of the mineral matter in the forage consumed by the grazing livestock is returned directly to the soil if the animals are kept on pasture continuously. The decaying grass roots add humus to the soil, and the humus in turn aids in converting the raw minerals of the soil into forms that can be used by plants. In addition, grass has a beneficial mechanical effect on the soil, tending to develop a favourable granular structure.

A large part of the badly eroded pastureland in most countries is the result of soil having been washed away

while the land was being cropped. When the soil became too poor to pay the costs of putting in a crop, it was abandoned by the plowman, and livestock were turned in to eat whatever would grow there. Such land, if it is to be devoted to pasture, should not be used without proper development and grazing control. Otherwise, erosion goes from bad to worse. Rather, it must be built up by the use of lime, fertilizer, and seed. That takes work and money, but it pays on most soils of fair fertility and is a necessary investment if such land is to be used for any other purpose than forest or wildlife production.

1. Selecting land for pasture:

Despite all the advantages of a pasture sod, it is not always possible to use all the land on a farm for pasture. It may be advisable to retain certain lands permanently in pasture, convert other lands from cropland to pasture, and build up abandoned croplands so that they will produce pasture. The extent to which pastures should be used in rotation with cultivated crops should be determined. The solution of these problems involving land use and conservation practices is made easier if the land is classified according to its capability, which depends on physical properties of the soil, the prevailing climate, and other factors.

2. Pasture on land suited for cultivation:

Lands classed as suited for cultivation are usually well adapted to the production of pasture. The levels of fertility necessary to produce moderate to high yields of cultivated crops on such lands are sufficient to produce profitable yields of forage for grazing and a vegetative cover for protection against rain or wind. Sometimes on

farms where all of the land is suited for cultivation a part is used permanently for pasture. However, it is generally much better to use all of the land in a rotation of cultivated crops, grain, and meadow or hay, pasturing the hay lands as needed. Such rotation pastures usually yield more than pastures that are kept permanently on the same land. This is partly because they are on land of somewhat higher productivity, partly because the tall-growing grasses and legumes commonly used yield more than those in permanent pasture. Plowing up pastures regularly and rotating them with cultivated field crops also helps to increase yields by reducing infestations of animal parasites.

The minimum period that the land should be in grass will depend on the class of land and the extent to which erosion-resistant vegetation, such as perennial grass and legume mixtures, is needed to protect the soil from erosion. Because of the cost of legume and grass seeds and the benefit to soil tilth when the land is in grass at least 2 years, crop rotations should be no less than 4 or 5 years in length. Among satisfactory rotations when other appropriate conservation measures are used, are the following:

Class I. 3 years of row crops, 1 year of small grain, and 2 years of legumes or grasses and legumes or continuous row crops where good winter cover crops are grown.

Class II. 1 year of row crops, 1 year of small grain, and 2 years of grasses and legumes.

Class III. 1 year of row crops, 1 year of small grain, and 3 years of grasses and legumes.

Class IV. Not more than 1 year of row crops, 1 year of small grain, and 4 to 6 years of grasses and legumes.

3. Land that should be put in pasture:

Upland not suited for cultivation may include (1) land that has either never been broken by the plow or was in cultivation for such a short time that little or no damage has been done, and (2) land that has been cultivated until it is no longer fit for crop production and must be converted to pasture or planted to trees if any economic returns are to be obtained.

Poorly drained wasteland, not suited for crops, may often be cleared and made to give profitable response to an expenditure for fertilizer, seed, and labour, but many areas of infertile, eroded upland can be used more profitably for woodland than for pasture.

Much land has been cleared which either never has been cultivated or was cultivated only long enough to get a stand of grass established. Such land is usually so low in fertility and so steep and erodible that it has been difficult to maintain a sufficiently good sod to protect the soil from erosion. Much of this land on the more clayey types of soil can be restored or maintained by applying necessary fertilizers, carefully regulating grazing, and following other good management practices such as weed and brush control and protection from fire. Disking or plowing may be necessary to establish or renew a stand of desirable plants, provided the land is not too steep, rough or rocky.

4. Seedbed preparation and seeding:

The seed of most of the plants recommended for permanent pastures are small, and the young seedlings are weak. It is necessary, therefore, to prepare a good, firm seedbed

and to cover the seed lightly. In humid areas, many farmers have followed the practice of seeding the grasses and legumes in small grain, considered a "nurse" crop. It is claimed that a light seeding of wheat, oats, rye, or barley takes the place of weeds and is less harmful to the pasture plants than are weeds.

The land to be seeded should be plowed and firmly settled. Just before seeding it is usually profitable, except on especially productive soil, to apply some 400 to 600 pounds per acre of a complete fertilizer known to be successful on small-grain crops in the vicinity. Fertilizers having approximately a 5-10-10 formula are generally effective. A light disking after the fertilizer application will put the soil in condition for seeding. Running a cultipacker over the land after broadcast seeding is one of the best methods for covering the seed. If no cultipacker is available, an ordinary spike-tooth or drag harrow with the teeth sloping slightly backward can be used. Usually a better, more uniform stand results if the seeds are drilled in lightly than when broadcast, and where the seeds are such as will flow through a drill the seeding and covering may be accomplished in one operation.

The amount and distribution of rainfall are often limiting factors in the establishment and maintenance of pastures. Before a good sod is formed, the loss of rainfall by runoff may be so great that the soil moisture becomes deficient for growth during periods of drought. Even on old pastures the effects of drought are first apparent on the slopes where much of the rainfall is lost as runoff. Small contour furrows help to reduce the runoff and thus conserve the rainfall and provide better conditions for seed germination and subsequent plant growth. Mulches and surface residues may also be used for this purpose.

5. Treatment of newly seeded pastures:

Care should be exercised in grazing newly seeded pastures. The young seedlings must have time to develop root systems in order to withstand drought, freezing weather, and the strain of being cropped by livestock. If many weeds appear in spring seedlings, it may be necessary to clip the weeds 4 to 6 inches high before grazing is begun. In any event the grazing should be rather light the first year. On clay soils, rolling early in the spring compacts the ground and helps to reset any plants that may have been heaved by frost. Moderate grazing is usually beneficial after the grass is well started.

6. Cultivating and reseeding:

Cultivation is of no value for the purpose of improving old pastures unless it is accompanied by reseeding or the application of fertilizer or both. Lack of desirable grazing plants in a mixture that formerly produced well is due generally either to a decrease in soil fertility or improper grazing. Cultivation alone cannot overcome either of these conditions; but cultivation in connection with fertilizing and reseeding has given excellent results by eliminating weeds, covering the seed, and mixing the fertilizer with the soil. Quick-growing grasses and clovers seeded on old-pasture sod that has been well disked and fertilized will give grazing in a surprisingly short time, and will continue to produce forage while the slower growing, more permanent grasses are becoming established.

7. Liming and fertilizing:

Most pasture soils in humid areas are deficient in calcium, phosphorus and nitrogen, and mahy are deficient in

potassium. All these elements are valuable in increasing the stand and production of desirable grazing plants and should be added when not present in the soil in sufficient quantity.

It is folly to expect fertilizers to produce a good growth of grass on inherently poor soils. Such land should be used for timber or wildlife production. On soils of fair natural fertility much can be expected from fertilization, particularly where the land has never been fertilized or has been neglected for several years.

If a fair stand of desirable pasture plants is present, fertilizer treatment is sure to result not only in a larger growth of the plants but also in an improvement of the stand, especially of stoloniferous plants, thereby enabling them better to compete with weeds.

Soils suspected of calcium deficiency should be tested to determine their needs for lime. In sections where lespedezas thrive, these legumes, which are not sensitive to acid soils, may well replace the clovers and make the application of lime unnecessary. Both lime and phosphate are believed to be more effective when they are worked into the soil than when they are applied on the surface.

Barnyard manure will furnish considerable nitrogen if applied at the rate of 5 to 10 tons per acre. The effect of such an application continues for several years. The effect of applications of commercial nitrogen is soon exhausted. Many dairy farmers use commercial nitrogen, applying small quantities from 1 to 3 times a season. Some prefer, however, to make one heavy application of nitrogen in the spring and rely on supplementary grazing crop for midsummer.

The mineral fertilizers, limestone and barnyard manure can be applied in the fall, winter, or very early spring. Commercial nitrogen should be applied about 2 weeks before increased growth is desired, as it results in a quick stimulation of the growth. Early applications may make it possible to begin grazing about 2 weeks earlier than could be done on unfertilized pastures. Applications of nitrogen are rarely effective in the absence of adequate soil moisture. Hence the returns from midsummer applications are often unsatisfactory.

Shade trees and shelters should be set on the higher parts of the field, and not along the banks of running streams. Thus, a larger part of the manure produced while the animals are not grazing will be voided on the land that produces the grass. Manure deposited on the upper slopes and hilltops has beneficial effects on the grass for some distance down the hillsides.

8. Controlling weeds and brush:

Increasing soil fertility is one of the best means of weed control, as generally grasses will dominate when they have favourable soil conditions. Mowing weeds at the proper time is another good means of control. In general, weeds should be mowed before the seed have formed. It is necessary to mow twice during the year to eradicate some weeds.

Sheep and goats are very efficient in keeping down many troublesome weeds, and many farmers have found it profitable to keep a few sheep in their cattle pastures because of their tendency to eat weeds.

Shrubs and tree sprouts can best be controlled by cutting them at the proper time. Apparently the best time

to cut brush is when the roots contain the smallest amount of starch. Generally, this is at time of blooming.

The eradication of sprouts and shrubs is generally more difficult in the warm countries than in the cold. Grubbing them out or treating them with chemicals has so far seemed the only sure way to eradicate them.

9. Effect of methods and intensity of grazing:

The good plants must have an opportunity to produce leaves and strengthen their root systems in the spring and throughout the growing season. Overgrazing in these periods will cause a reduction in their subsequent growth. Grazing pastures closely in the late fall, before the plants enter their dormant period, is likewise harmful because the plants are prevented from building up a reserve food supply in the roots and a fair cover of foliage to protect them from injury when their vitality is low and conditions are unfavourable.

In the humid areas, forests are the usual climax type of vegetation, and trees will dominate over grass if man does not interfere. In such regions fairly close grazing is helpful in maintaining a grass cover. Browsing by goats helps to prevent brush and trees from occupying grazing lands. In general, reasonably heavy grazing favours plants that require light for their best growth.

On the other hand, in arid and semiarid regions, where grasses are the climax form of vegetation and may even conquer hardy shrubs, continuous heavy grazing is destructive rather than helpful. The plants have a short period of growth because of the scarcity of soil moisture during a large part of the year. They cannot maintain their vitality, and therefore cannot perpetuate themselves by seeding or

storing plant food in their subterranean parts, if they are closely cropped throughout their growing period each year.

The selective grazing that results when the use of a pasture is limited to one kind of animal is likely to affect the quality of the pasture adversely. Horses are likely to graze local areas very closely and to leave other areas wholly untouched. On the other hand, they may be used to graze down a pasture that has largely or completely grown up to coarse herbage. Any rough herbage left uneaten can be removed by mowing late in the summer. Sheep are much inclined to select the more tender grass and the tender tips of weeds and bushy plants. One of the rules for maintaining a uniform grass-legume mixture in humid regions is to graze it all down close at least once a year.

10. Effect of burning pastures:

No general statement can be made regarding the advisability of burning pastures or ranges, except that indiscriminate, uncontrolled burning is usually harmful. Much depends on the kind of vegetation, the time of year, and the soil and weather conditions when burning takes place. Pastures and ranges are burned over for various reasons - to destroy dead herbage which was unconsumed the previous season and remains to interfere with the grazing of new growth, to control weeds and brush which otherwise might replace the desirable pasture plants; or to destroy pine needles and other forest litter which tend to smother out the forage plants on cut-over timberland. When fire is so used, care should be exercised to prevent its spread to adjacent fields, forests and farmsteads.

11. <u>Pastures compared with harvested crops</u>:

The labour needed to maintain permanent pastures after they have been established is relatively small. In a number of typical cases the labour required for fence repair and replacement has ranged from 1 to 3 hours of man labour and less than 1 hour of horse labour per acre per year. The principal other labour requirements have been for occasional jobs such as the application of fertilizer and weed and brush cutting. The charges for interest and taxes were fully as low as for other similar acres of the farm. Even annual and other temporary pastures, although costing as much as grain crops to produce, are harvested cheaply by livestock with practically no labour cost.

Studies which have been made of the effect on meat quality of using grass in the ration of grazing animals show that the meat of suckling lambs produced on good pasture is as satisfactory both as to fatness and palatability as that from suckling lambs which received a supplement of grain on pasture. The results of these studies also indicate that production costs can be lowered by making greater use of pastures in the fattening of livestock.

Fresh green pasturage grown on fertile soil provides, in a palatable form, most of the substances required for perfect animal nutrition. Pasturage, which is rich in protein, minerals, and vitamins, maintains the health and productivity of livestock. It permits the animals to replace the stores of minerals or vitamins which have been used up during the winter and enables them to lay up a supply for use during a period of inadequate nutrition. Good pasturage appears to be a perfect feed for all herbivorous animals except those doing hard work, those giving large quantities of milk, or

animals that are being fattened rapidly. On the other hand, long-continued feeding of herbivorous animals on poorly cured roughages is detrimental to both production and reproduction.

Although certain types of injury to animals caused by parasites and diseases may be largely avoided by keeping livestock in dry lots or barns, animals generally are better off on pastures. A clean pasture not only provides natural conditions for the livestock but also reduces the labour of caring for the animals and minimizes the danger of mineral and vitamin deficiencies.

Pastures provide breeding animals a means of obtaining the exercise needed for healthy development and full production and give work animals an opportunity to obtain the exercise they need to maintain themselves in good condition when not actively at work.

Immature pasturage consisting of both grasses and legumes has feeding properties similar to those of high-protein concentrates, such as the oil-mill byproducts. It is especially well supplied with protein, minerals, and vitamins, and is richer in protein and more digestible than the best mature hay. The protein in good pasture plants is high in quality as well as in quantity. The protein in the leaves is particularly valuable for supplementing the protein deficiencies of the cereal grains.

Several methods have been developed to preserve immature forages for use in winter and other periods of shortage. In one method the grass is dried by artificial heat and either stored as hay or pressed into small cakes to facilitate handling and shipment. In either form the dried herbage usually maintains its green colour and agreeable odour. When used in the rations of cattle and sheep, it has proved to be a satisfactory substitute for oil-mill byproducts.

Green, immature grass is a much better source of minerals than hay or mature plants from the same land. It is generally about twice as rich in phosphates as mature freshly cured grass, and may be from 4 to 5 times as rich in phosphates as mature grass which has been exposed to the weather for several months. The dry matter of immature grass contains practically 4 times as much mineral as the average cereal grain, and as much as the average legume hay. Furthermore, pasturage produced on fertile land probably contains considerably more of the important minerals than that produced on poor soil.

An adequate supply of vitamins is necessary for proper growth and reproduction in livestock and to keep them thrifty and resistant to diseases. Vitamin A, for example, promotes growth and increases resistance to disease. When animals are grazing on green, immature pasturage they appear to be better supplied with vitamins than by any other practical method. Such feed is especially rich in carotene (from which Vitamin A is made in the animal body), and contains other less well-known vitamins of importance to animals.

The palatability of pasturage depends on the kind of plants, their tenderness, stage of maturity, density of stand, and climatic and soil conditions. In addition, livestock tend to select plants which contain relatively high percentage of minerals in preference to those having a low percentage of the same minerals. The palatability of most grasses is greatly reduced by seed-head formation. Hence, mowing or close grazing at heading time helps to keep the forage palatable.

12. Grazing practices and livestock management:

On small farms and where livestock produces a minor part of the farm income, a common farm practice is to use whatever pasture is available or can be most readily supplied for the kind of livestock to be kept. Usually the pasture supplements other feed. But where grazing is the chief source of feed for livestock or where the bulk of the farm or ranch area is in pasture, the problem is to choose the kind or kinds of livestock best suited to the pasture. On most farms, greatest returns will be obtained from the forage available and the pasture will be kept most productive if two or more kinds of livestock are grazed, either at the same time or at different times during the season. Where large areas of several kinds of pasturage are available, or where so few animals are kept that it does not pay to provide separate pasture, all kinds may be turned on the same area.

As farm animals may suffer from the heat of summer days, some sort of shade should be provided. If there are not sufficient trees or brush, sheds or other shelters should be built. If they are for summer use only, all sides should be left open. The roof may be of poles, brush, or straw. About 15 square feet of roof surface are required per head of mature cattle. For protection against cold, rains, and sleet the more exposed sides of the shelters should be walled. Where there is little rainfall but much cold wind, windbreaks like tight fences, rows of trees, or bluffs can be used for protection.

Rotation grazing is the grazing of two or more pastures in regular order with definite rest periods for each pasture. When only two pastures are involved this type

of grazing is sometimes known as alternate grazing. Under certain conditions, rotation grazing of permanent pastures may increase the production from 10 to 15 per cent over continuous grazing.

Although pastures are conducive to the general health and vigor of livestock, precautions should be taken against certain diseases and parasites. Tuberculosis, for instance, though much less common among cattle on ranges than in those confined much of the time in barns, may be spread by such means as infected watering holes and ponds. It is apparent that the droppings of tuberculous animals in the water supply may pollute it sufficiently to infect other cattle that drink the water.

Since a pasture on which cattle are kept only during the time they are grazing receives only a small quantity of manure, it loses its fertility faster than a pasture on which cattle remain the full 24 hours of each day. On many dairy farms the portion of the pasture easily accessible from the farmstead is likely to reach a very low state of fertility. This is due in large part to the custom of keeping the cows at or near the farmstead during the night, and applying the ma ure thus saved to other parts of the farm instead of to the pasture.

### E. Conservation Irrigation

The term "conservation irrigation" is relatively new. Only in recent years has it become part of the terminology of irrigated agriculture. "Conservation irrigation" is simply using irrigated soils and irrigation water in a way that will insure high production without the waste of either water or soil. It means using cropping

irrigation, and cultural practices that will maintain the land in permanent agriculture.

To the farmer, conservation irrigation can mean savings in water, control of erosion, better crop yields, lower production costs, and assurance of continued productivity from his irrigated land. For many farmers, it can mean a start toward the final solution of alkali problems, waterlogging, and numerous other evils now prevalent over large sections of the country.

In these sections, the need for conservation irrigation is urgent. Until recently, more water has been their chief concern. Little attention has been paid to the conservation of soil, or, for that matter, of water. Ironically, the careless handling and unwitting waste of this irrigation water is responsible for many grave difficulties which now confront irrigated agriculture. For waste water can lead to wasted land.

Throughout the development of irrigated agriculture, the major concern has been water. Much progress has been made in the harnessing of rivers and the construction of vast canal systems for distributing water to the land but too little attention has been given to the land itself. Particularly, proper care has not been taken to insure wise and efficient use of either the land or the water used in irrigation farming.

1. Wasted water, damaged land:

Many land and water problems of grave importance confront irrigation agriculture to-day. In many areas there is more land suitable for irrigation than can be irrigated with the amount of water available. Yet over

widespread sections less than half of the water applied to the land actually benefits growing crops. This waste of irrigation water usually causes land damage by erosion, alkali accumulations, leaching, or waterlogging. It often increases irrigation-water and farming costs.

Soil erosion is as great a menace to irrigated land in arid regions as it is to land in humid regions. Moreover, in arid regions, soils are generally shallow and light in texture. Also, they are now in organic matter, which leaves them highly subject to both wind and water erosion.

Erosion is threatening the continued productivity of more than half of all the irrigated land. A quarter of a million acres are losing topsoil at the rate of an inch every 3 years, according to our best estimates. Another half million acres are losing soil at the rate of an inch every 5 years. This loss represents a permaennt land-investment loss to the farmer. Attempts to grow crops on land not suited for them contribute to the damage. But most of this damage results from misuse of irrigation water.

Besides the erosion damage, uncontrolled irrigation water also causes serious drainage problems and salt accumulations on many irrigated bottom lands. Or, if the surplus water passes through the root zone, it leaches out plant foods. Where the water collects to form wet spots, alkali salts may concentrate. Some of this alkali land is still being farmed, but with reduced yields and less profitable crops.

Moreover, every gallon of water that is either pumped or purchased is money wasted out of the farmer's pocket when the water is wasted. This waste increases the cost of producing crops, in addition to the damages the land and crop may suffer.

Soil structure has broken down in fields where row crops have been grown too long. The combined effects of this broken-down soil structure, erosion, and depleted organic matter have made these fields less and less able to take water. Their productiveness is on the downgrade.

Much of the damage to irrigated land is due to irrigation runs that are too long. These are the cause of the severe erosion in many areas. Long runs also contribute to water waste and leaching. To get water to the lower ends, the upper ends must be overirrigated.

Delivery of irrigation water in open ditches contributes heavily to water loss. This loss may be as much as 70 per cent. The average in the western part of the United States is about one-fourth of the volume of water carried. Most of it is due to seepage. If seepage water is not recovered by return flow, it is lost to agricultural use. In any case, it is lost to the farmer who purchased or developed it. Heavy weed growth in canals slows down the flow of water - besides reducing the capacity. And this reduced velocity increases canal losses from both evaporation and seepage.

Improper methods of logging and heavy grazing on the watersheds that produce the irrigation water have created other problems. They have changed the flow characteristics of the streams in many irrigated areas. Streams and rivers which once gave a steady water supply throughout the growing season now flood more often in the spring and deliver less water during the rest of the year. In places, additional storage has had to be built. Silt carried down from these unprotected watersheds is filling in many reservoirs. Silt has also added to the debris that must be removed from irrigation and drainage canals.

2. <u>Problems can be solved</u>:

There are practical ways to solve most of these problems in irrigated areas. They involve basic principles of soil and water conservation; and they require an accurate knowledge of soil, topography, water needs, and the capability of the land to be irrigated.

An irrigator practicing conservation irrigation has control over his irrigation water from the time it enters the ditches and on down until a small part leaves as waste water. He is able to apply the water in such a way that it wets the root zones of his plants with the least practicable loss from runoff or from percolation.

On many farms a different method of irrigating is needed. Some also need drainage, supplemental water supplies or land levelling.

Irrigation systems carrying water to the farms need to be studied to find out what can be done about improving water delivery and cutting down seepage losses. Often better delivery schedules and improved management will stretch the available water supply.

Soil-building crops in rotation with cash crops need to be grown more extensively to add organic matter to the soil.

Reforestation and better range management are needed for some watersheds. Measurement of both water and snow accumulations will aid in better planning for the seasonal use of the available water.

3. <u>Conservation irrigation on the farm</u>:

Conservation irrigation on the farm is simply the use of the irrigation and cropping methods that best fit the particular soil, slope, crop and water supply. It makes possible irrigation without erosion damage, alkali accumulation, waterlogging, or undue water loss.

Conservation irrigation can be established on the farm by the following steps:

<u>Get an inventory of the soil and water resources</u>: The soil on the farm needs to be examined for depth, texture, structure, permeability, available water capacity, and productivity. A soil conservation survey map showing these and other factors, such as slope, past erosion, and seep spots, will provide the required detail. The amount of water available on the farm must be determined as well as how the water is made available through the irrigation season. If the water supply is not adequate, possibilities for improving it should be studied before plans are made for the farm.

<u>Decide how to apply the water</u>: The methods used to apply water must fit the land. Also, they must fit the crops needing irrigation. Finally, they must fit the water supply available.

<u>Plan the distribution system</u>: The farm irrigation-distribution system must be designed to get enough water to all parts of the farm when needed. It should also provide for the safe disposal of any waste water.

Prepare the land: All fields must be prepared so the water can be applied with maximum efficiency. To accomplish this some land may need to be 'levelled'.

Make efficient use of the irrigation water: Adjust the size of water streams so that they will not cause erosion but will apply just enough water to satisfy crop demands. Where there is alkali in the water, special methods may be needed to prevent its concentration in the plant root zone.

4. Irrigation methods to fit the land, crops, and water supply:

The water supply, the soil, the topography, and the crops to be irrigated determine the correct methods for applying irrigation water. Irrigation requires careful attention to all these factors.

The ability of different soils to take in and hold water differs greatly. Some soils absorb and hold large quantities. Others take water very slowly or have little holding capacity.

A thorough knowledge of the way the soils absorb water and the capacity of the different soils on the farm to store water is vital to conservation irrigation. If more water is applied to a particular field than it can readily absorb, both expensive water waste and erosion occur. Knowledge of the water-holding capacity of the soil makes it possible to apply just enough water to satisfy the needs of growing crops but not enough to cause waste and damage.

Once the water-intake rates and the storage capacity of the soil are known as well as the amount of irrigation water available and the method of delivery, the cropping programme can be adjusted to these conditions.

Some of the more common methods of irrigating and their use in conservation irrigation are described and illustrated on the pages that follow. Specifications for each method have to be worked out to fit the soil, climate and water supply of each area. The Soil Conservation Service has prepared specifications for nearly all irrigated areas of western United States. These specifications are based on scientific research, field tests and local irrigation experiences.

<u>Basin irrigation</u>: The purpose of this method is to fill a diked area of land with water to the desired depth quickly and allow the water to go into the soil. When basins are properly graded and built to the right dimensions for the kind of soil and the water supply, water can be applied efficiently.

<u>Border irrigation</u>: This is a controlled way of flooding the surface of a field. The idea is to advance a sheet of water down a narrow strip between low ridges or borders and to get the water into the soil as the sheet advances. It requires that the strip be well levelled between the border ridges, and the grade down the strip be fairly uniform to avoid ponding. The ridges should be low and rounded so they can be planted with the strips. Then no land is taken out of production.

<u>Contour or bench-border irrigation</u>: This method is adapted to fairly uniform moderate slopes with deep soils. The strips are laid out across the slope on a controlled

grade, and the ridges are constructed parallel to each other.

Corrugation irrigation: In this method the water is applied in small furrows. It then moves laterally through the soil between the furrows to wet the entire area. The method is designed for heavy soils that take water slowly and that seal over and bake when flooded. It is recommended also for close-growing crops on steep or rolling land.

Furrow irrigation: Furrow irrigation is the most common method of irrigating row crops. The water is applied in the furrows between the plant rows. Many of the present furrows are too steep for safe irrigation. This fact has been the greatest single cause of erosion by irrigation water. Because cultivation to control weeds keeps the soil in the furrows loose, it is easily eroded.

Contour-furrow irrigation: This is the method of applying water in furrows across rather than down sloping land. The furrows are given just enough grade for water to flow, but not enough to cause soil washing. Deep-furrow row crops can be irrigated safely by the contour-furrow method on cross slopes up to about 8 per cent.

Broad-furrow irrigation: On slopes not exceeding 3 per cent for most soils, the use of broad-bottom furrows in place of the usual narrow V-type furrow will increase the rate of water intake and reduce furrow erosion. This method is recommended for orchards planted on contour benches, as a means of eliminating erosion resulting from grade variation along the benches.

Sprinkler irrigation: Where it is adapted and where crop returns can support the cost, sprinkler irrigation provides excellent control of the water applied to the soil.

Water may be applied with sprinklers at a rate that the soil will absorb without runoff. Sprinklers can be turned off when the soil has absorbed the right amount of water. Because the water can be so carefully controlled, sprinklers have special uses in conservation irrigation. For example, they can be used to establish pastures on steep slopes. Sprinklers, however, cannot be used universally. In hot windy climates, much water is lost through evaporation and wind drift causes uneven water application. On very heavy soils, because of the low intake ability the rate of applying water may have to be so low that much of it is evaporated before it enters the soil.

Controlled flooding: In this method water is flooded downslope between closely spaced field ditches which keep the water from concentrating and causing erosion. Frequent openings in the ditches allow a uniform distribution of water over the field.

5. Preparing land for conservation irrigation:

Few operations are of greater importance to conservation irrigation than the proper preparation of land by grading and levelling. Low spots, which allow concentration of water, may cause waterlogging or may bring harmful salt deposits to the surface. High spots, which do not receive enough moisture, result in reduced yields. Irregularities in slope make it very difficult to control water velocities, a frequent cause of erosion.

The extent to which land should be graded and levelled is governed largely by the depth of soil. Care must be taken not to make levelling cuts that would leave the root zone too shallow for the crops that are to be grown.

The method of water application to be used influences the degree to which land should be levelled. With sprinkler irrigation, little levelling is necessary. For furrow irrigation, land must be brought to a nearly uniform slope if soil and water losses are to be avoided. Border irrigation requires careful levelling within the borders for proper distribution of water along the strip. The specific requirements for grading and levelling for each method have been worked out through research and practical experience. They differ with the locality, depending on the soil and other physical conditions and on the crops to be grown.

6. Improving the water supply:

On irrigated farms where there is not enough water or where the supply is uncertain, it is often difficult to establish all the soil and water conservation measures needed. The only answer may be to find some way to improve the water supply. Some solution to the problem should be found before even an attempt is made to establish the soil and water conservation measures.

In some areas irrigation-water supplies can be both increased and stabilized by improving the condition of the watershed that produces the irrigation water. In some, supplemental water supplies can be developed. In others, putting the diversion, storage, or delivery systems into good operating condition will increase the effective water supply on the farm. For example, conveyance losses can be reduced by lining canals, using closed conduits, and controlling weeds in the canals and ditches.

If no way to improve the water supply can be found, the only thing left to do is to choose crops that fit the

supply at hand. This may mean growing crops that require less water, or it may mean confining the use of the water to the best land.

Chapter X

## SOCIAL ASPECTS OF AREA DEVELOPMENT

All development activities aim at human welfare. Area development is no exception to this. The latter, however, focuses it's attention more importantly on the development of local resources and talents and on more equitable distribution of the fruits of development among the people. In the previous chapters we had paid attention to natural resources. In this chapter, our emphasis will be on social resources.

### A. Human Resources

True assessment of the human resources of an area is possible only if we look into the quantity as well as the quality of the people. By quantity, we mean the number of people; by quality, we mean their physical and intellectual capacity to produce goods. We are quite familiar with the census figures regarding the number of people according to age, sex, occupation and so on. But such figures are not of much avail when it comes to small rural area development. Here, we have to pay more attention to the skills, motivation, values and aspirations of the people. Additionally, we have to pay attention to the mode of working of the people, specially in matters of co-operative endeavours.

Skill survey of the area would reveal the type of activities which could be immediately promoted. It would also indicate the activities to be promoted in future. One of the major objectives of rural area development planning must be to train people for new opportunities. New jobs must be created to improve the consumption level of the people, and they must be adequately trained to improve their production level.

While analysing the human resources, the age ratio should be studied carefully. It is indicative of the quality of population. More children and aged people mean greater burden on the society. More schools and health facilities would be needed. This also gives how much of the educational and health facilities should be provided. In normal circumstances, 15 per cent of the population falls in school age category. If there are 1000 people in a village, one can safely assume that about 150 children require schooling. Similarly, a health centre can cater to no more than 5000 people.

Standards have been prescribed for all social facilities in India, but most of them pertain to urban areas. There are standards for housing, drinking water, education, health, communication, etc. We need not accept these standards as final; we should prepare new standards based on local experience.

B. Social Structure and Regional Development

The social structure of the developing societies, whether conceived at the national or regional levels, is inhibitive of real development. The benefits of increased investment in economic and social activities in these areas go to those who need them least. It is not infrequently that it further accentuates poverty. Let us see how it happens.

To explain this, we would make use of an analogue model from earth sciences. There are three types of model structures: Porous, permeable and impermeable (fig. 10.1-a).

The porous structures with equal size particles allow liquid to get to the whole stratum through percolatory or

capillary action. The structures are such that the liquid cannot by-pass any particle, whether the process is percolatary or capillary, so long as there is enough liquid to fill the stratum. Nor does it allow retention of the liquid by individual particles beyond its bare minimum capacity to hold it. Any supply in excess of the bare minimum goes to the bottom layers. Societies exhibiting such social structures can be called porous societies. The second type of societies is marked by permeable structures (limestone structures). It allows the liquid to pass down but only through the network of joints well-linked with each other vertically as well as horizontally. Societies which exhibit these structural characteristics may be called permeable societies. The third type of structure is impermeable. It consists of hard, solidified and metamorphosed rocks. Liquids can percolate only to the extent there are crevices in them. Otherwise, they are contained by the uppermost layer to be radiated back to the atmosphere in course of time. Societies with such structural rigidities can be designated as impermeable societies (fig. 10.1-b).

In a porous society, investment to raise the level of living of the people percolate downwards, upwards and sidewards so that every individual benefits almost equally from it. This leads to greater participation of all the people in the productive activities. None progresses unless all progress; and cooperation rather than competition becomes the basic philosophy of life. Surplus production getsrecycled for mutual benefit or in an inter-regional system, gets invested in other regions to bring about inter-regional equity in development.

In a permeable society, developmental investment is monopolized by a minority; part of it percolates down to a

# PHYSICAL MODEL OF SOCIAL STRUCTURES

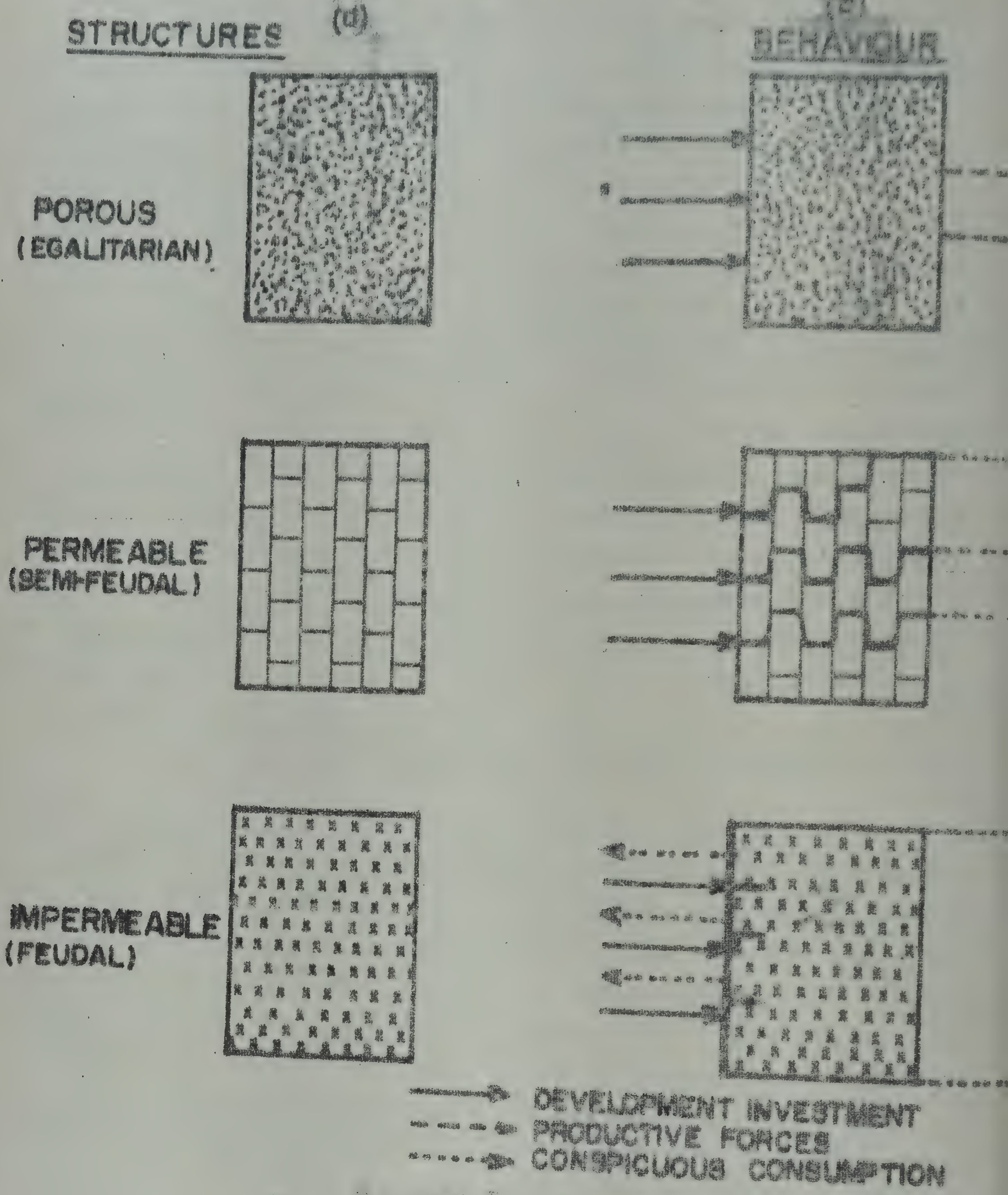


Fig. 10.1

variety of middlemen vertically and horizontally linked with each other on the one hand and with the monopoly groups on the other. A majority of the people have no direct access to these investments; they come to them as residuals through the middlemen. Greater investment means greater monopolization and further strengthening of the social system through the institutionalization of what was earlier discrete individual activity. This type of society is marked by conspicuous consumption and vulgar display of wealth by the wealthy minority and the gradual acceptance of the privileged group as the peer group, by the poor majority. The third type is one where almost nothing percolates downwards. It is completely monopolized by the uppermost stratum of the society.

The above three types of societies are almost coterminous with sociologically defined egalitarian, semi-feudal and feudal types of societies. The new nomenclature is, however, more indicative of the processes which operate within the structural constraints of socio-economically defined societies. The first and the third are the 'ideal types' - the first in the positive sense, and the last in the negative sense. Most living societies conform to a variant of the second type; and it is this type with which we are concerned in this paper.

When we examine the problem of poverty of a region or a group of people within the framework of the social realities explained above, we cannot but conclude that to think of poverty as the cause of low productivity of the masses, and to approach the problem of poverty in terms of productivity alone is ridiculous. "Many of the traits that characterize developing societies such as the lack of productive and remunerative employment, the inability to

distribute the fruits of growth so as to relieve mass poverty or to narrow the gap between minorities enjoying modern consumption pattern and the rest of the population; the inability to accord the masses either the reality or the feeling of participation in decision-making - have in different combinations become prominent in advanced countries (too) and have weakened their credibility as models for the development of the rest of humanity".* Yet our models of development persistently ignore the social structural inability to assimilate change and to diffuse the benefits of development to those who have been bypassed by historical economic forces and processes. They rely heavily, if not completely, on truncated thinking on investment and production as the basis for all developments.

The old strategy based on the assumption that poverty can be taken care of through growth which must trickle down to the poverty stricken masses, has not borne the fruits for the simple reason that the existing class relations are enemical to it. Wherever it has been pursued without adequate safeguards, it has proved to be counter-productive further strengthening the process of monopolization. We know fully well that "development is not merely a question of how much is produced, but what is produced and how it is produced. . Institutions which create growth are not neutral as to its distribution. Thus, if growth institutions are characterized by disparities in land-holding and concentration of industrial wealth, the process of growth will strengthen them further and they will resist and

* J.B.W. Kuitenbrouwer, "On the Concept of Process of Marginalization" Occasional Paper No. 37, The Hague: ISS, 1973.

frustrate all future attempts to take away their powers and privileges through orderly reforms".*

It is exactly the situation in which national and regional development efforts are being made in India. Each plan and programme for development has led to more poverty and more unemployment. Economy as a whole has indeed grown; national strength has improved at times beyond expectations. But the institutional reforms to strengthen the 'filter down' process and to enable the masses to participate in national endeavours and to benefit from the contributions they make to it, has been frustrating. After going through several cycles of land reforms, we find ourselves where we were to begin with. These and other reforms have yet to make a major dent in the semi-feudal or permeable social structure we inherited from the British Raj. Twentyfive years of planning has now brought us to that fundamental problem of which we ought to have been adequately aware - mass poverty resulting not so much from lack of production as from the lack of opportunities to produce.

## C. Social Policy Framework

In the light of the above, development has to be redefined as the process or processes through which a society acquires greater porosity within its own body politic and thus enables its members to gain greater control over themselves and their environment. To achieve this, all societies, but more so the developing ones, whether conceived in the national, regional or l...

* Kuitenbrouwer, op.cit.

local[1] terms must consider social structured change as their major task. It is this change which should form the major component of social development. The provision of health, education, recreation and similar other facilities is only a secondary aspect of social development. What is primary is the transformation of a permeable society into a porous one. That is at least the direction in which we have to move to weaken, if not to eliminate completely, the monopolist minority and to bring them in the mainstream of development.[2]

Following Utria,[3] we could enlist the following main objectives of a social development policy suited to developing countries like India:

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1. The processes of monopolization and marginalization cut across political and administrative boundaries and operate at international, national and local levels leading to inter-areal and inter-personal disparities in development. While at the inter-national levels the national states and multi-national corporations monopolise the resources, at the national level the regional governments, monopoly houses and their feudal subordinates do the job. The malady is so deep-seated that values of monopolization pervade down to local and individual levels and each person tends to exploit the others.

2. The concept of mainstream needs some definition. It is often said that one of the objectives of development is to bring the poorer sections of the society into the mainstream of development. If development is conceived in terms proposed in this paper. then it is the upper stratum of the society consisting of large farmers, "intellectuals", businessmen, political bosses, bureaucrats and their allies, who have to be brought in the mainstream.

3. Rule D. Utria, Appendix to "Social Aspects of Regional Development in Latin America", <u>International Development Review</u>, No. 4, United Nations, New York, 1972.

(a) To motivate, prepare and organize individuals and the community to replace the traditional concepts, motivations and attitudes by others which are more favourable to development;

(b) To transform social structures and institutions, through the individual and the community, particularly as regards (i) re-structuring of production, (ii) changes in social structures; (iii) cultural change; and (iv) changes in political (and legal) structures;

(c) To accelerate social mobility so as to involve the population fully in the benefits of development and facilitate a steady improvement in the social condition of its under-privileged sections through the introduction of more dynamic structures for the ownership and use of productive resources and through effective system of income distribution and redistribution.

(d) To create and fortify an economy and an economic policy that will ensure productive employment for the whole population ..., the expansion and efficient use of national resources and an adequate supply of goods and services to meet the genuine needs of all sections of the population;

(e) To accelerate and direct the general process of modernization by the absorption and assimilation of appropriate technological and scientific advances in all walks of life and activity, especially those which sustain the poorest among the poor.

(f) To consolidate and raise the level of social well-being by improving the organization and aims of social services and other elements of the level of

living with special attention to those who are marginalized.

(g) To promote and mobilize popular participation at all levels and on all fronts, both in decision-making and in the execution of development tasks by focusing on those aspects of development which concern the poor majority.

(h) To create a national image and a sense of achievement through systematic efforts to speed up development by carrying out a task which was perceived to be too difficult.

(i) To concern itself with the various phenomena and circumstances involved in the self-fulfilment of the individual and the community and the preservation of human dignity.

If we accept the above, then social policy becomes the main dynamic factor of development; it brings economic policy in tune with social objectives and proves beyond doubt the "irrelevance and uselessness of social policies and programmes whose scope and objectives are limited to filling selected gaps in particular social services such as housing, medical assistance, education, recreation and so on. It also shows how undesirable it is to formulate economic policy without previously giving due consideration to social problems and to the social implications of economic development model and strategy adopted".*

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* Rule D. Utria, op.cit.

## D. Target Groups and Regional Social Policy

It has been emphasized earlier that the poorer sections constitute a large segment of developing societies. This applies equally well to developing sub-national regions and areas. It is these poverty-stricken people who should constitute the target groups in our planning exercises. Our social development policy must aim at full participation by these people in the production and distribution processes.

But who constitute the target group? Attempts have been made by individuals and national and inter-national institutions* to evolve indicators of poverty and development. A universally acceptable set of indices has proved to be illusive. In our own country, several seminars and symposia have been organised to evolve methodologies for identifying the poor.+ We may perhaps continue these exercises for the benefit of researchers. In the mean time, lest our work is hindered, we could use a simplistic procedure to get quick results. Poverty is not an abstract phenomenon. It is here and everywhere. One has only to see in ones own backyard. We need not, therefore, wait for research reports before formulating policies and the action programmes to implement plans, programmes and projects designed to improve the conditions of the poor. In the case of India, we could use three criteria to identify the poor. These are:

1. Social status as indicated by caste/community,
2. Educational status, and
3. Income or property status.

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* Specially, UNRISD, Geneva.

\+ This refers to ICSSR sponsored workshops in different parts of the country.

For the purposes of identification of the poorest among the poor, a set of cordinal and/or ordinal indices could be worked out, on the lines suggested below.

| Class Ordering | Index | Caste Ordering | Education Ordering | Income Ordering |
|---|---|---|---|---|
| Upper | 4 | Upper caste touchables | Graduate + | More than 20 times PCI* |
| Upper middle | 3 | Intermediate caste touchables | High school + | 10 to 20 times PCI |
| Lower middle | 2 | Lowest Caste touchables | Primary school + | 5 to 10 times PCI |
| Lower | 1 | Untouchables | Literate | Less than 5 times PCI |
| Lowest | 0 | Tribals | Illiterate | Less than PCI |

Supposing that two persons get the following rating

| | A | B |
|---|---|---|
| Caste | 3 | 1 |
| Education | 2 | 0 |
| Income | 1 | 1 |
| | 6 | 2 |

It could be said that B is thrice as backward as A. The maximum score one can get is 12 and the minimum is 0. Now we can link the various classes with scores.

* PCI = Per capita income in the country.

| Class | Score range | |
|---|---|---|
| Upper | 11 - 12 | |
| Upper middle | 9 - 10 | |
| Lower middle | 6 - 8 | |
| Lower | 3 - 5 | Target group |
| Lowest | 0 - 2 | Target group |

The above classification can be fruitfully used to identify the target groups. The people with lowest status rating should be the immediate concern of the planners. The planned action must aim at improving their social, educational and income status. To improve their bargaining power vis-a-vis the kulaks, monopolizers, and other vested interest groups, the concept of social development would have to concern itself primarily with social relations and only secondarily with the provision of social facilities like health, education, recreation, etc.

In the first place, a massive effort will have to be made at the national and regional levels to bring the children of the target groups to the school. The proposition is, however, not so simple to implement, for the obvious reason that a child is the product of the status of the parents. He inherits the poverty in all forms - social, economic and others. He is guided by the aspirations of the parents and the overall environment in which he is born and brought up. It is, therefore, suggested that at least one standard primary school should be built by the Central Government in all the taluks/tehsils of India, during the Fifth Five Year Plan. These schools would have the same facilities which the best urban schools have, plus the lodging and boarding facilities. Half of the children of these schools should be drawn from the target groups and the other half from the rest of the people. Integrated development of the two groups is essential from the long-term social point of view. The task of these schools

should be to see that every child admitted progresses on desired lines and goes to higher schools where he gets full support from the government to move ahead. More such schools can be built gradually to cover all the members of the target group. Space does not permit further elaboration of this scheme here. Suffice it to say that if implemented in right earnest, it would raise the educational level of the poorer sections within a decade.

As regards the economic status, the social development policy should aim at immediate nationalization of all natural resources including land. It should also prohibit acquisition of property for social exploitation. The property may be categorised into three types (1) private property, (2) trust property, and (3) State property. No single family should be allowed to own private property worth more than 50 times the per capita income. If the per capita income in 1980 is likely to be Rs.1000/- per annum, during the decade 1970-80, a family of six members can have private property worth Rs.3 lakhs. The remaining private property should be declared as trust property and suitable rules could be made for its administration. The benefits accruing from a trust property should go to the welfare of the weaker sections. The above property classification should apply to urban and rural areas alike and similarly to agricultural and industrial sectors alike.

Since a majority of the people belonging to the poorer sections of the society live in the rural areas, the land resources after nationalization have to be so distributed that the poor become the major beneficiaries. In this regard the following proposals could be considered seriously for implementation:

1. The available land should be distributed among agricultural families equitably so that each family would get about 1 to 2 hectares. The compensation for the land acquired from large farmers should be for a maximum of five hectares minus the land assigned fo him after redistribution. The compensation should be given in the form of new agricultural enterprises like dairy, poultry etc., so that the maximum desirable level of household income is not reduced. Since better off farmers are more prone to adopt innovations, this policy would not force them out of agriculture.

2. The farm families should be grouped into a set of twenty or twenty-five and massive assistance in terms of new enterprizes, services, input, and marketing channels should be given to each group to increase productivity.

3. To accomplish the above, the local and regional services through decentralization and even at the cost of national and State level services should be strengthened and entrusted with the task of being at the service of the people.

The implications of the above for regional development are indeed far reaching. Regional development then can shed its obscurantist task of drawing regional boundaries, and allocating funds to uncoordinated schemes of development, and tune itself to the task of comprehensive socio-economic planning and development at a variety of areal levels - blocks, talukas, districts, states, etc. There could be three approaches to development then:

1. Area approach - Development of the physical and human resources;

2. Target group approach - Development of the weaker sections; and

3. Economic approach - Developments designed to maintain and improve the productivity of the region vis-a-vis other regions.

The first approach should lead to the development of natural resources - land, water, flora and fauna and physical and social infrastructure, etc. If the underground water is available only in a given zone, it has to be tapped and used by whosoever has the land near the source. Similarly, a canal can give water to fields on the lower side of its own level. If a major road has to be built, it has to follow a given alignment; there is nothing that can be done about it. But what can be done is compensatory development projects for those who have not benefited from the area approach projects.

To carry the benefits of development to those who do not benefit from the area approach because of disabilities imposed on them by the society and its laws, target group approach to development would have to be resorted to. Each household of the target group should be given a package of activities which enables it to become economically viable - here viability means earning capacity equivalent to prevailing per capita income. We should be able to evolve models of viable rural families within which households with different economic and socio-cultural status could be fitted.

For the success of a social policy outlined above, development has to be attempted in a multilevel territorial framework. Region should not be construed to be an isolated sub-national territory. It should be considered as a sub-set of larger set linked vertically as well as horizontally with each other. Each region or sub-region has its own peculiarities with respect to the social situation. While it is true that much of what can be done at

the regional level in terms of social development would have to be decided at the national level, it is equally true that a national policy to be of any operational significance must be interpreted in regional and local terms. Here lies the importance of regional sociology and regional social structure.

As an operational strategy, we could consider a two-sector model of rural development - the private sector and the co-operative sector. It is the co-operative sector which needs to be made broad-based and strong. If necessary, each village should have special purpose co-operative, catering to needs of the weaker sections exclusively. To make them viable, their activities should encompass production and agro-services too. Instead of each small farmer owning every piece of agricultural implements, etc., it could very well be owned by co-operatives which can do custom job for the co-operators. This may ultimately lead to co-operative farming.

Conclusions:

In conclusion, we can restate that the existing approaches to regional development lack a comprehensive social policy with the result that the poorer sections of the society do not benefit adequately from the planning and development activities. Social development involves far more than provision of certain social facilities like education, health, housing, etc. It involves a conscious effort to make structural changes in the society and aims at a porous or egalitarian society.

Given a comprehensive social development policy, the approaches to regional development should be two fold:

area approach and household approach. The latter approach is to attack the problem of poverty at its grass-roots level. The households of the poorer sections of the society should constitute the target group in regional development. The objective should be to make each household viable through co-operative endeavours.

Chapter XI

## INTERSECTORAL INTEGRATION OF AREA PLANS

It is now a well accepted concept that there exist close interrelations among different sectors of human activities. Development of a particular activity is possible only if these activities which impinge on its development are favourable to it. In other words, otherthings remaining favourable, a particular change would occur. While for analytical purpose one may dispose of this whole problem, by saying 'other thing being equal or same', it is of no great help to a practical planning exercise.

Integrated rural area development requires that all sectors of the rural economy are so planned and developed that one supports the other. To this, we must know the relationships among various activities. While, one has to find out these relationships in each area of planning, a practical exercise in this respect worked out by J.G. Krishnayya and S.K. Sharma of Indian Institute of Management, Bangalore, is reproduced below as an example of how to attempt inter-sectoral integration of plans.

### A. Agriculture Sector Linkages

'Agriculture' encompasses a whole spectrum of activities like farming vegetables and fruit growing, animal husbandry, poultry and fisheries. Inputs to and/or the factors that affect the Agriculture Sector are as follows (grouped in the order of importance):

#### Farming

1 (a). Land:

Land affects the agricultural sector through the following parameters:

i) Soil Composition: determines the type of crops that can be grown, the number of crops that can be grown, the yield per hectare, and the mix of fertilizers to be used.

Taking some examples - black loam soil with its moisture retaining property is essential for growing cotton - the nutrients content of the soil is an important variable in determining whether you can grow 2 or 3 crops on the same field and also determines the yield - soil deficient in phosphates will have to be given a strong dose of p-fertilizers.

ii) Location: In conjunction with fertility (soil composition) determines the price of the land which in turn affects the gross area under cultivation. Land nearer to a town or village, an irrigation scheme, the market, a processing industry which uses the produces, is likely to be costlier.

The climate and topography - dependent on location - influence the technology to be employed and the crops to be grown. For example, if the terrain is hilly one needs to do terracing - paddy requires heavy rainfall or flooding, etc.

iii) Size of Land-holdings may determine the efficiency with which some inputs like fertilizers, pesticides, mechanical implements (tractors, harvestors) can be used, or the speed at which innovations take place.

1 (b). Labour:

Both skilled and unskilled labour are needed on the field: skilled for ploughing, sowing, irrigation, use of

fertilizers and pesticides, and unskilled for purely mechanical operations like harvesting, thrashing, etc.

Labour can be the family members of the farmer (which is most often the case) or it can be hired hands.

1 (c). Water:

The pattern of rainfall is most crucial. The whole agri-economy of India hinges around how the monsoon turns out.

Then we have the artificial means of irrigation - canals and wells. Wells again can be of two types: (a) Dug wells, (b) Tube wells.

Canals and wells provide as and when needed water supply, removing the uncertainty of monsoons. Adequate water supply can lead to a change in the type of crops grown and also the crop pattern.

2 (a) Seeds:

On seeds depend the yield per hectare and other minor properties like disease resistance, protein content, etc. Seeds can be classified as: (i) Local, (ii) Improved and (iii) HYV.

HYV is a hybrid variety of seeds and by definition of a hybrid, the crops grown from them do give us HYV seeds, so HYV have to be produced through a chain of special seed farms (manned by agri-scientists?) and for every crop sufficient quantity of HYV seeds has to be produced. Because of this HYV seeds become a 'conventional' production - distribution system.

The HYV should reach the farmer in time for sowing and in requisite quantity. Also encountered is the problem of purchasing power. It should be possible for the farmer to purchase the HYV with available funds (which are function of credit facilities, of which we shall talk later). There have been occasional complaints in the press about the inequitable distribution of HYV seeds, largely a responsibility of the government.

In short, efficient production and distribution of HYV seeds is a pre-requisite for sustaining the green revolution.

2 (b) Fertilizers and Pesticides:

Fertilizers supplement the nutrients in the soil to help increase the crop yield. Different fertilizers may be needed at different points in the growth cycle of the crop. They can also be used to make cultivable land with sub-standard soil. Other fertilizers along with rotation of crops are used to replenish the soil nutrients after a crop has been grown. Proper mix of fertilizers can be used for making the soil more suitable for a particular type of crop.

Fertilizers are either: (i) Indigenous/or (ii) Manufactured.

Indigenous fertilizers include green manure / and compost organic material which can be produced at the village level.

Manufactured fertilizer are the chemical fertilizers: N.P.K. types (Nitrogen, Phosphates, Potash). They again can be viewed as a production distribution system.

In addition to a supply system, fertilizers need educational support in terms of teaching the farmers the 'how', 'when' and 'what' of fertilizer usage. Also needed are mechanical implements for efficient application of fertilizers.

Pesticides are protective measures. Farmers need to be educated in the safe and effective use of pesticides. There can be different pests infesting a region or field and accordingly rodenticides, herbicides, insecticides or fungicides have to be used. Occasionally rapid dissemination of know-how and pesticides is required to fight a crop disease or pest. Because of the breeding pattern, HYVs are particularly susceptible. Also needed is equipment to effectively apply these pesticides.

3. Tractive power:

There are two sources of power for use on the field:

i) Animal power: The animals used on the farm differ from region to region - horses, camels, buffaloes, bullocks. Human labour labour is not insignificant.

ii) Mechanical power: Tractors and power tillers are increasingly being used in the Indian fields.

Tractors and power tillers are an obvious choice (in spite of oil crisis?) if the sole criterion is productivity. But they require high initial investment. Tractors are hard to use hence inefficient and often uneconomical on the average size of land holding in India, assuming that the farmer could raise enough credit to buy one. Leasing services change the picture as do the secondary uses of the

power source, especially for the highly time-critical activities characteristic of modern agriculture.

4. Mechanical implements and servicing:

As has been mentioned previously mechanical implements are needed to disperse fertilizers and pesticides on the field, to do the seeding, for irrigation, for harvesting and threshing etc. Attachments to tractors can provide many of these services.

All these implements improve productivity but again, they need high initial investment.

Once these implements are in use it is essential that facilities are provided for prompt servicing and repairing of these. Which means that sufficient technical know-how has to be generated locally or has to be brought in from outside.

5. Power:

'Power' is being spoken of here in the sense of static motors or devices which are used in different operations on and around the field: Operations like harvesting, threshing, irrigation.

There can be three types of motive power:

i) Animal or Manual,
ii) Diesel, and
iii) Electricity.

In category (ii) it could be a diesel engine or it could be a tractor itself with its power take-off attachment which is acting as a prime mover.

Electricity taken from a power supply grid requires a complex chain of supporting systems including installation, maintenance and protection of feeder transmission lines and transformers, as well as a metering, billing and collection system.

Now we move over to software inputs.

6. Credit:

All the inputs that we have mentioned above have to be bought with money. It is not possible for a vast majority of Indian farmers to purchase all the 'hardware' inputs to improve their productivity without substantial credit support.

A farmer gets credit from mainly four sources

1. Private Money lenders,
2. Co-operative societies,
3. Banks, and
4. Personal savings.

The most dominant among these at present is the private money lender and this has far reaching impact on the marketed surplus as we shall discuss when we come to the market structure. Private money lenders also charge high rates of interest. It indicates a need for increasing the reach and effectiveness of bank and co-operative society activities, and for them to provide a full package of services.

7. Extension network:

Even after the farmer has got the essential inputs for farming, he needs to be educated in the proper use of those inputs. He should be told about HYV and its

advantages, mix of fertilizers suitable for his crops and conditions, advantages and dangers of pesticides, etc.

Farmers need to be kept up-to-date in - all these areas. Publicity is needed for all the schemes government devises to improve farm productivity; beyond that, the farmers should be aided in making use of them by the way they are integrated and presented.

The extension network for this already exists, and it has been utilised reasonably successfully and efficiently to introduce HYV, and other practices. Included in Extension is the effective use of communications media like drama, films, radio, newspapers, pamphlets, etc.

8. Post harvest operations and marketing:

Crops require some post-harvest operations such as threshing and some, such as rice, require major milling activity immediately.

Storage and Transportation: Systems are the link, filter and barrier between the farmers' economic world and the consumers. Disadvantage of good farm level storage facility could be increased (speculative) hoarding. On the other hand the amount of the crop withheld for the farmer's own consumption includes his estimates of spoilage (which is usually 25%). Better on-farm storage conditions should therefore release a larger surplus to market. Better transportation facilities reduce the cost of marketing.

Market structure: There are regulated markets and there are private dealers working through 'Adhetiyas'. The variables that become relevant here are how much the farmer sells, to whom and when.

If the produce is sold through a regulated market it provides a fair price for both the seller as well as buyer with adequate weight and quality control.

But as mentioned earlier the farmer depends for his credit mainly on the 'seth' (since banks do not provide credit for marriages and social functions) and is under some sort of obligation to him. Now this 'seth' is usually a trader also and he can get the farmer to sell the produce to him,thus interfering with the play of "market forces".

How much and when are determined by the economic condition of the farmer and the prices. If the past one or two years have been good for the farmer, he has a buffer of savings and can afford to sit on his produce waiting for prices to go to a 'favourable' level. Also since he is not in urgent need of money the quantity he will sell will be less.

Conversely, if his economic condition is bad because of bad crops for the past year or two, the farmer will bring the produce to the market as soon as he can and as much as he can, regardless of the prices.

The quantity and timing of the crop sales (assuming the demand to be inflexible) affect the prices.

9. Co-operatives:

Formation of co-operatives is increasingly gaining ground. Co-operatives are organized bodies for providing support to the farmers in the form of credit, storage, and marketing facilities. They also form an efficient channel for distribution of fertilizers, HYV seeds and pesticides.

Co-operatives are also a medium for effective dissemination of information about technological and other developments and provide leadership in adoption of innovations.

10. Prices and gross income:

If the farmer can afford to wait, the prices will affect the surplus he brings to the market.

Also, in general, prices determine the type of crops that a farmer would like to grow. Everything else being suitable (if he has enough land already under food crops for his own consumption) his preference would be to go in for a cash crop yielding higher earnings.

The prices and the quantity marketed determine the gross income of a farmer. A farmer's gross income in time 't' determines the inputs he can afford to buy in time 't'+1 which in turn affects the quantity produced.

11. Government policies:

Government is the largest producer and distributor of fertilizers, producer and distributor of HYV, as well as the biggest single purchaser of the agricultural produce. It also influences the agricultural sector through rural electrification programmes, extension and development work, finance for co-operatives, directives to banks on credit policy and the purchase prices of various commodities. Crop levies, movement controls and taxes are other forms of government action.

12. Industry:

Proximity of a processing industry which uses a particular agricultural produce as input, is likely to

increase the inclination towards producing that commodity. For example, if there is a sugar mill nearby, it is possible that the farmers would switch over to sugarcane, because they save on the cost, effort and time of transportation.

Then there are some factors which have a direct but not quite measurable impact on agriculture.

13. Health:

The physical condition of the former influences the time and effort he can put in on the fields and thus has a direct impact on the productivity. Health of his family members determines the help he can get on the fields and his mental peace.

14. Education:

Education moulds a farmer's attitude towards learning new techniques and applying them as well as determines his capacity to do so.

It also brings about an increasing awareness and consciousness which enables the farmer to take advantage of various developmental schemes and also to make the most efficient use of the available resources.

Influence of Agriculture: Effect of agriculture on other aspects of rural life is predominantly through a single transducer - economic condition - an individual's as well as of the community.

Taking demand as inflexible, the quantity of output determines the prices; the prices and the quantity marketed determines the gross income. Gross income of the farmer determines the amount of money to be spent on education of the children, health of the family, etc.

The prosperity of an agricultural community determines the spending on public works programmes like building roads and storage facilities and forming of co-operative societies and regulated markets.

A prosperous economy boosts up the level of political goodwill fund. It also attracts industries which can use the main produce of the region as raw material.

Non-economic impact of agriculture is on the socio-cultural scene which includes variables like food habits, festivals, social customs, etc.

A loop type of relationship can also be identified. The gross income of the farmer determines the inputs he could afford for the coming crop and the amount of inputs will determine the quantity produced.

## Vegetable and Fruit Growing

The analysis for this activity is also quite similar to that of Farming except that:

i) Greater play of demand and supply, and cost and price economics; not so much of government interference;

ii) Mechanical implements needed do not require as high investment; and

iii) Since these commodities are perishable, the storage facilities (cold storage) and accessibility of market in a short time become critical factors.

## Animal Husbandry and Poultry

The prevalent caste system in rural India determines the persons who can take up a particular type of occupation.

For example 'higher' caste people will not keep cattle except for milking or breeding purposes. Butchering and dealing in meat is left to a different group of people. Same is the case with poultry.

Apart from that, here also the storage facility (for milk products as well as meat and eggs) and proximity to market are important factors.

A completely new type of facility has to be developed for this activity - veterinary hospitals and artificial insemination centres.

Different types of inputs namely nutritious cattle and poultry feeds are needed. The extension network also has to employ a new type of specialist - one who knows about the fauna being promoted.

This activity is dependent upon farming for fodder.

## Fishing

Fishing is a specific type of activity in the sense that proximity to natural or artificial reservoirs of water is essential. Coastal, tidal and, river and pond fishing are quite different.

It can give us a substitute food as well as substantial foreign exchange earnings. Input 'industries' (for nets, implements, boats) and 'post harvest' operations - cleaning, packing, freezing, canning, etc. are economically significant as a system.

See figures 11.1 and 11.2 for diagramatic representation of the above analysis of agriculture sector linkages.

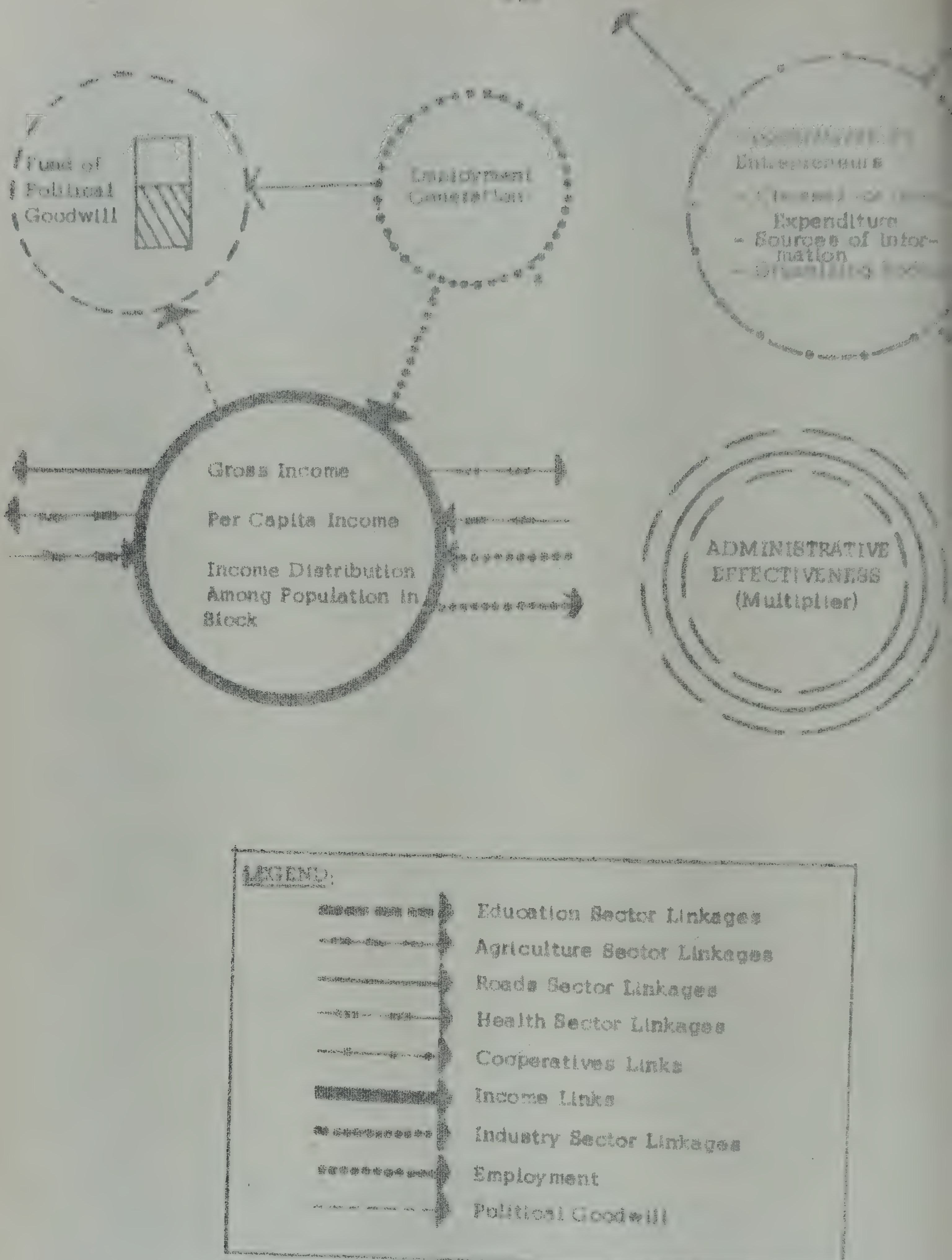
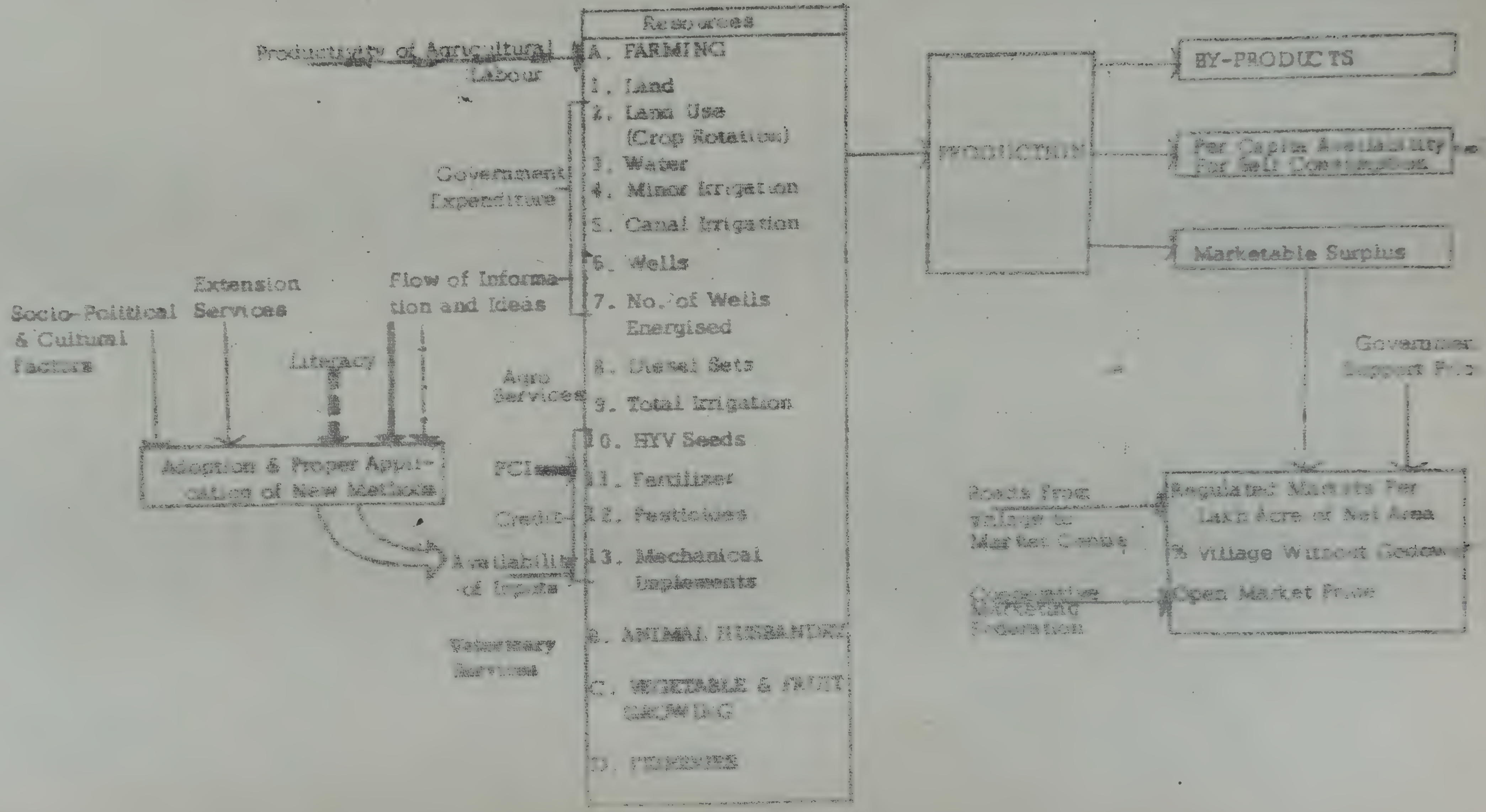

Fund of
Political
Goodwill
Employment
Generation
Entrepreneurs
Expenditure
- Sources of Infor-
mation
Gross Income
Per Capita Income
Income Distribution
Among Population in
Block
ADMINISTRATIVE
EFFECTIVENESS
(Multiplier)
LEGEND:
Education Sector Linkages
Agriculture Sector Linkages
Roads Sector Linkages
Health Sector Linkages
Cooperatives Links
Income Links
Industry Sector Linkages
Employment
Political Goodwill

Fig. 11.1

## AGRICULTURE SECTOR



## B. Industry Sector Linkages

Industry, in the rural context, can be categorized into three segments:

1. Village Artisans: like the blacksmith, the carpenter, the mochi, the tailor, the potter, the silver and goldsmith, etc.
2. Cottage industries: like spinning, khandsari, handicrafts, handloom etc.
3. 'Conventional' industries: (which generally come to the urban mind when 'industry' is mentioned) like saw mills, printing press, dal and rice mills, workshops etc.

A particular industry is set up in a region due to any of the following reasons:

1. It uses the main crop of the region as a raw material, or it is involved in supporting the 'inputs' to local agriculture.
2. There is some mineral like iron or copper ore.
3. Preference of the entrepreneur, or as an ancillary to a big industry, and
4. Other advantages like tax concessions and land facilities provided by the local government.

These reasons are relevant for the 'conventional' industry only. The first two categories of industry are mostly for satisfying local needs and therefore there is no deliberate decision-making process in their location. They sort of sprout in response to the need of the region.

The factors which invluence the industrial sector are as follows:

1. Location: There are different aspects of location which affect not only the decision to locate the industry there but also the operations of the industry. But since these aspects are important by themselves we shall discuss them individually. Here we could just mention that with a particular location, a particular climate and particular topography are tied up and they influence the efficiency of the operations. For some industries, like cotton textiles which requires a certain minimum level of humidity, climate becomes critical. Location also affects the first input to any industry - land prices.

2. Raw-materials: Availability of raw materials at an appropriate price is critical to the functioning of any industry. Also important is the time factor, i.e., there should be a timely and regular inflow of raw materials.

For the village artisan and the cottage industry, raw-materials are easily accessible because they usually utilize locally available resources. It is also quite common that the producer of the raw material and owner of the industry are the same person, e.g., a farmer who grows sugarcane also has a khandsari unit in his backyard. Village artisans, quite often, do not have to worry about raw materials because the customer himself supplies it like in the case of tailors, goldsmiths, etc.

3. Natural resources: include minerals and water. The existence of minerals can lead to mining and/or processing industry. Water is essential for all industries of category (3) and hence a plentiful source of water supply is a major consideration for these industries.

4. Labour: Unskilled as well as skilled labour is needed for all the three types of industries. Large labour requirements or need for special skills leads to inflow of labour. Availability of local labour is influenced by education and the skills it has been possible to impart to the local populace, through the education system (which includes vocational training institutions). Also to be considered is the opportunity for alternate employment. It has been found that education beyond a certain level leads to expectations of white collar jobs and manual work is shirked by those individuals. Often this results in migration to urban areas.

In industry of category (1) and (2) skills are passed from father to son and there is no felt need for formal vocational education.

Health has an important influence on productivity of labour.

5. Capital: The most important input to an industry, along with land and labour, is capital.

Source of capital can be any of the following:

i) Savings (which is a function of per capita income),

ii) Credit: from

a) Banks
b) Industrial Development Corporations
c) State Financial Corporations
d) Private Financiers
e) Credit Cooperatives, and

iii) Public subscription.

6. Technical and managerial know-how: In industries of categories (1) and (2), as already mentioned, technology involved is very simple and the know-how is transferred

from father to son. The management of these enterprises does not require any sophisticated technique.

But for category (3) industries, relatively sophisticated technology and management know-how is needed. It is quite obvious that these inputs cannot be available locally and therefore there is an inflow of people with appropriate skills.

Some amount of simple technological know-how, more relevant to categories (1) and (2), is provided through extension programmes sponsored by the government.

Co-operatives also prove of help particularly in providing some managerial support.

7. Marketing: Before deciding what to produce and how much, one has to look for the demand and needs.

For the village artisan, it is purely the local (either just at the village or at the nearby mandi) need, which is meaningful. The cottage industrialist can think of exporting his product but he needs organizational help which is provided by handloom cooperatives or bodies like khadi gramudyog commission.

'Conventional' industries export practically 100% of their output and the local needs have no effect on their demand except perhaps indirectly.

Another part of market forces are prices. But they will also be more influential in the 'conventional' industry segment rather than the local market.

8. Electrification: The amount of electricity consumed is the most appropriate indicator of industrial development.

But again, this won't be fully applicable to category (1) and (2) industries. If the village is electrified, the village artisan will have an electric bulb to work under and some increase in productivity will accrue. The khandsari unit will use an electric motor to run the cane juice extractor. The increase in productivity due to the availability of electricity is an observable phenomenon.

In 'conventional' industry electrification is critical to the setting up of the plant itself.

9. Major crops: They might not have such a big impact on category (3) industry unless and until it uses the agricultural produce as its raw material.

The most closely related to the crops is the cottage industry. Though some activities like handloom and handicrafts might not be dependent very much upon the type of crops in the region but khandsari, spinning, 'ghani' etc. owe their existence to the crops grown in the area. Other 'cottage' industries such as leather are linked to animal husbandry. Canning and food preservation industries also depend upon agricultural output.

The market for the village artisan is essentially dependent upon the prosperity generated by the crops in the region.

10. Communications: It includes roads and transport. All the items to be exported need efficient connections to the market. Also the raw materials can be imported efficiently through well developed roads and communications network.

Quite evidently category (3) and to some extent category (2) industries are influenced by this aspect of the infrastructure.

11. Government policies: 'Government' here includes central, state, and local governments like Panchayat as well as some other bodies like Khadi Gramodyog Commission, etc.

The following aspects of government policies influence the development of industries in general:

i) Technical extension services and marketing cooperatives;
ii) Loans and capital grants;
iii) Subsidies and taxes; and
iv) Expenditure on developing facilities like industrial estates and other infrastructure.

Influence of industry: The output of the industry can be measured in terms of units produced, rupee value of production or values added.

Economy: Apart from satisfying needs through the outputs, the industry also affects the economy of a region through the following two parameters:

a) Per capita income, and
b) Employment level.

An increase in per capita income leads to better health and education.

Employment level has an opportunity cost attached to it. For example, a farmer might leave his fields to join as an industrial worker and thus bring down the agricultural production.

Multiplier effect: Once an industry has been established it attracts other supporting industries and services. It also draws an industry which can use its output as an input.

Non-economic influences of the industry are as follows:

Health: There are occupational diseases associated with certain industries.

Education: Setting up of an industry generates a demand for certain types of skills and knowledge. This requires that the education system be geared towards imparting those skills and knowledge.

Population: This is mainly influenced by category (3) industry. As mentioned earlier 'conventional' industry needs lot of manpower with diverse skills and this leads to inflow of people, changing the mix of the population in the region.

Socio-cultural system: Inflow of people of different social and cultural background leads to a sort of cross breeding and emergence of a new configuration of morals, ethics and values. Empirical evidence suggests that there is some degeneration as a result of industrialization.

Political goodwill: Since it improves the economic environment of a region, industrialization is generally welcome. This is supported by the evidence that as the elections draw near, more and more foundation stones are laid for one industry or the other or for some input to the industry.

Diagramatic representation of the above analysis is given in fig. 11.3.

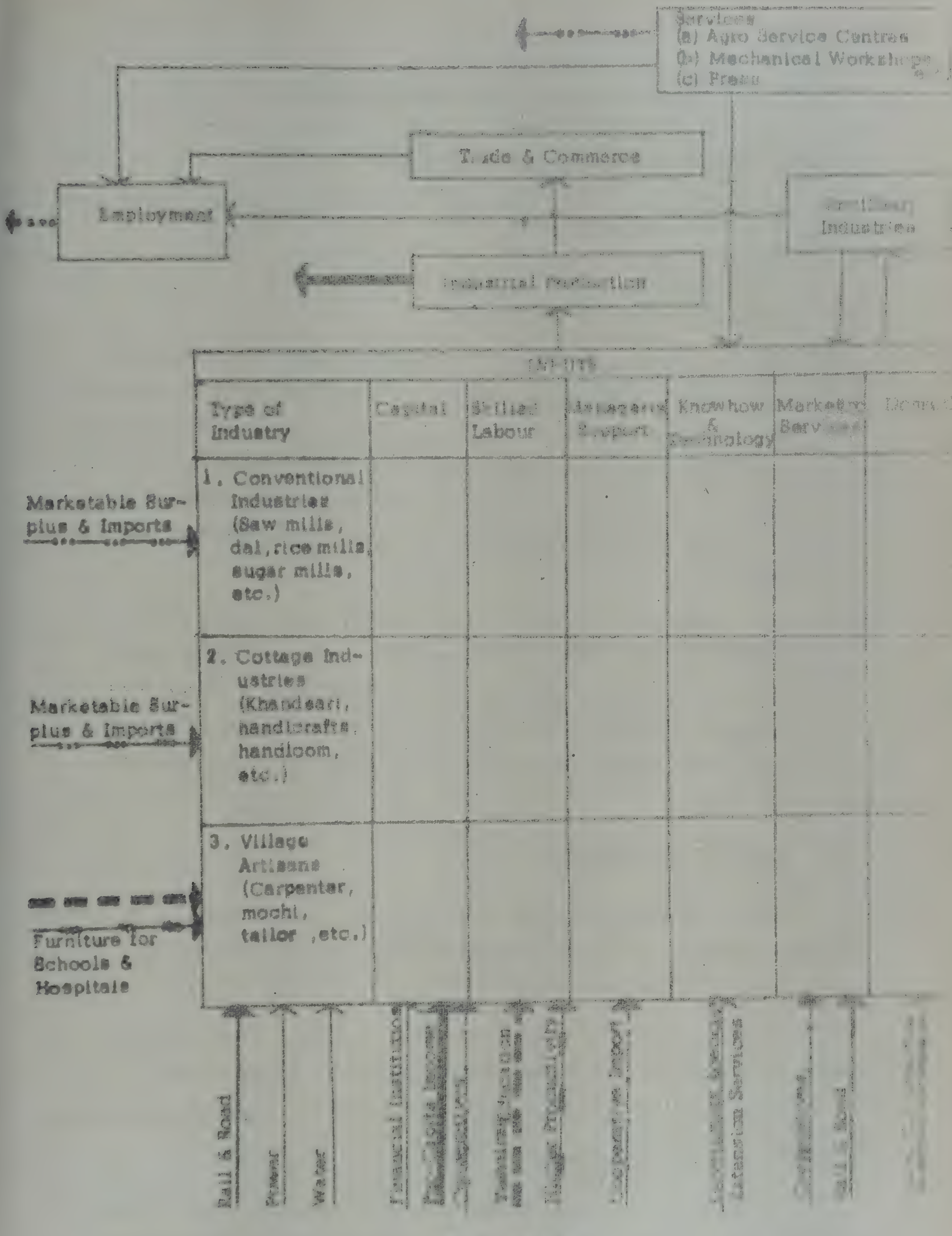

Services
(a) Agro Service Centres
(b) Mechanical Workshops
(c) Press
Trade & Commerce
Employment
Industries
Industrial Production
INPUTS
Type of Industry
Capital
Skilled Labour
Knowhow & Technology
1. Conventional Industries (Saw mills, dal, rice mills, sugar mills, etc.)
2. Cottage Industries (Khandsari, handicrafts, handloom, etc.)
3. Village Artisans (Carpenter, mochi, tailor, etc.)
Marketable Surplus & Imports
Marketable Surplus & Imports
Furniture for Schools & Hospitals
Rail & Road
Power
Water
Financial Institution
Extension Services

Fig. 11.5

## C. Roads and Linkage Sector

### A. Factors that influence road construction:

Roads facilitate the flow of material, men, services and information.

1. Geographical factors:

I) Topography: Influences the cost of construction and maintenance of roads and the type of road. Rivers increase the cost of the road by necessitating bridges. But they may also serve as a substitute mode for transport and communication. Cost of roads rises steeply as we move from plains to the hills.

ii) Climate: Most of the rural roads are unsurfaced, and many of them which are covered with clay become very slippery and unusable during the monsoon months. Poor grading, runoff, and drainage make the roads unusable for a considerable period of time.

2. Flow of materials:

Main products which flow out of the village are agriculture, dairy, and poultry products, fish, fruits and vegetables.

The demand for roads depends on tons per year of these products (surpluses) moved out of the village.

Production of the above products in turn depends upon the flow of inputs into the village.

Inputs are fertilizers, seeds, pesticides, petrol, oil and lubricants, spareparts, agricultural implements, etc., which can be classified as agricultural inputs. Other

inputs into the village system are kerosene oil, cakes and other consumer goods which have to be supplied from the other centres. Quantities of these commodities moving inward can be termed as material inflow.

The necessity to have a road, and a road of a particular type, would greatly depend on the quantity of inflow and outflow of materials in the village system.

The inflow of materials depends on the number of persons in the system and their purchasing power (a function of per capita income) as well as the effective cropped area and the farm technology in use. The quantity of agricultural surpluses flowing out and inputs into the system depend on the size of the holdings, income level of farmers and level of modernization of agriculture in the village.

3. <u>Flow of men</u>: Roads facilitate the movement of:

(a) i) Persons from home to the field,

ii) People from home to the market centres.

iii) People and livestock from village to hospitals and veterinary centres.

(b) i) Students from home to schools

ii) Teachers to villages

(c) i) Village community to their place of worship/entertainment, and

ii) Village community to their relatives outside the village.

4. <u>Flow of services</u>: Roads facilitate the movement of service personnel, government and private, like extension workers, workers, doctors, craftsmen, mobile dispensary, family planning worker, hawkers, traders, etc.

5. In sum, utilization of the road depends on the number of persons using the road and the amount of material transported over the road. In effect men and material movement create the demand for roads.

6. The type of road required depends on the mode of transport used which in turn depends on the speed of transport used which in turn depends on the speed of transport required.

| Mode of transport | Type of road |
|---|---|
| a) on foot | foot path |
| b) a + animal drawn carts | cart tracks |
| c) a + b + petrol bus, jeep, tractor, etc. | unsurfaced roads |
| d) a + b + c + trucks | surfaced roads |
| e) all types of vehicles | all weather roads |

Number of the above vehicles in the system and the kilometers of the above type of roads per square km. of area of the system give us a set of state variables which influence the demand for roads.

Another set of influential state variables are the distance of the village from major service centres.

a) distance from railway station
b) " " market centres
c) " " processing centres like rice mills, cotton gin, oil mills, etc.
d) " " pilgrimage centres
e) " " entertainment center/hospitals, etc.
f) " " pucca road
g) " " all weather road.

7. Road construction depends on the ability to finance and obtain finance for construction and maintenance.

B. <u>Factors that are influenced by roads</u>:

The most powerful impact of roads is: (i) creating accessibility and (ii) reducing the time spent on route.

Roads increase the income level of the population in the system through increasing the productivity of agriculture, dairy, poultry and other rural activities and reducing the cost, time and effect involved in marketing.

1. <u>Improvements in agriculture</u>:

Roads facilitate the inflow of information and knowledge through more visits of extension workers, etc. and over a period of time, are instrumental in changing the attitudes of the villagers towards modern methods. When farmers become more mobile they are likely to be exposed more often to new ideas and methods.

A study has shown that proximity to roads leads to: (i) improvement in land use; (ii) more acreage under cash crops and (iii) specialization in crops.

Seeds, fertilizers, pesticides, etc. and other inputs become more easily available leading to changes in farming methods and increased agricultural production.

Farm mechanization would increase as drilling rig can move to the interior and drill tubewells. Petrol, oil, lubricants, spare parts, etc. can reach the village and help to maintain pumps, tractors and agriculture implements.

2. Another very important result of roads is the provision of speedier transport to transport perishable

commodities from villages to market centres. Therefore poultry, dairy, fishery, fruit and vegetable production would go up. These products bring daily cash flow to the villager as against twice a year cash flow if he produces only grains. This leads to flexibility in finance and the farmer would release his surpluses when prices are favourable and thus would realize higher income. Of course, this tendency may lead to storage of foodgrains in poor condition resulting in higher losses in the system.

3. Education: Teachers would be more willing to go to the villages served by roads. Better attendance may be expected. Female literacy is likely to increase. A broader range of school facilities would be available to the students.

4. Health: With accessibility to hospitals, dispensaries, etc. and the increased number of visits of health family planning workers, mobile dispensary visits, etc., the health status is likely to improve.

5. Industries: Rice mills, agro-service centres, ginning mills, oil mills, etc., would be more accessible to the village. Roads may lead to establishment of cycle shops, agro-repair shops, etc.

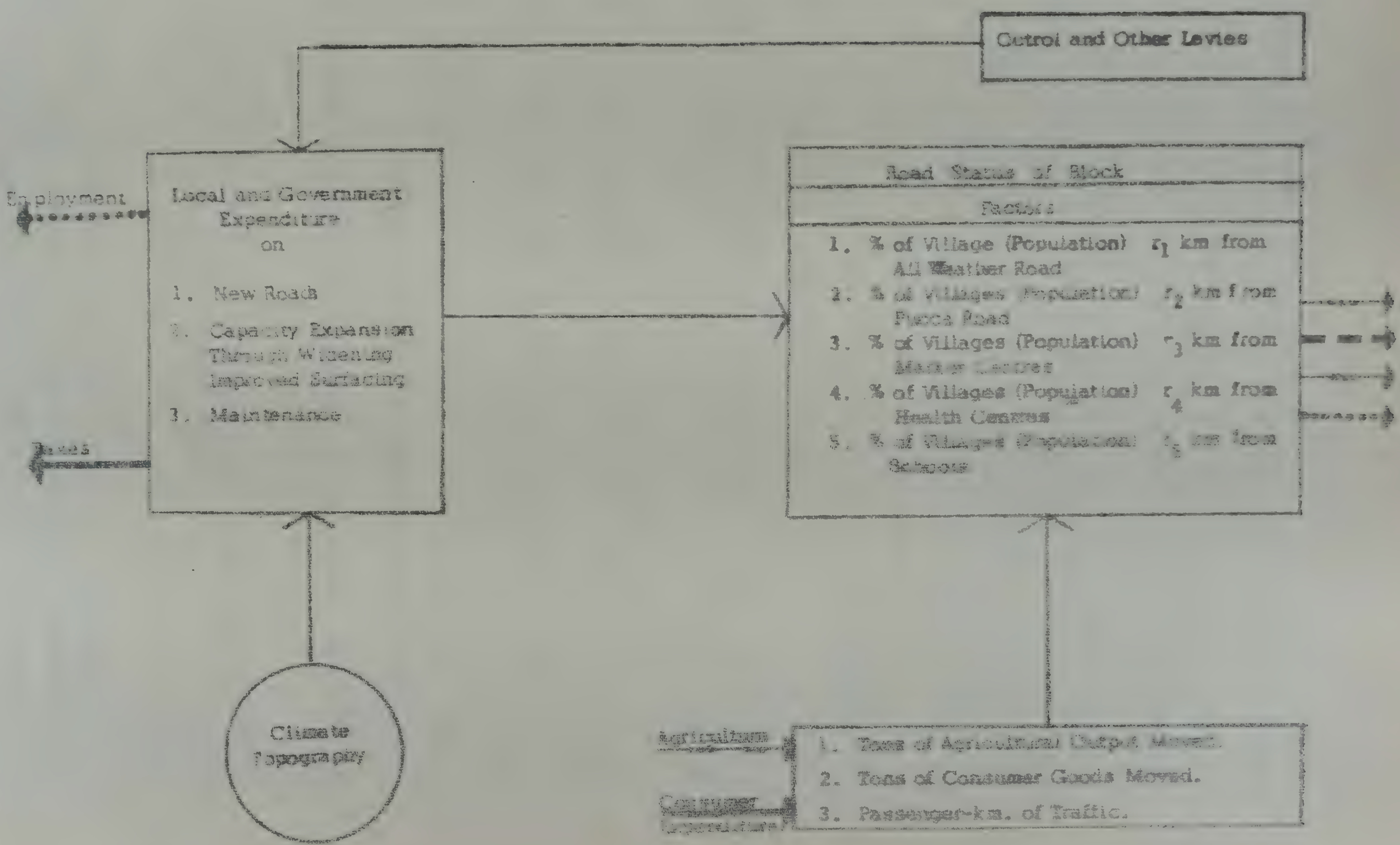
6. Having sanitation and electricity, easier transport of building materials, would improve the quality of housing, sanitation and provision of electric service lines.

7. Improved connectivity and the resultant increase in economic activity will boost the political goodwill in the populace towards authority.

C. <u>Decision variables</u>:

1. In some states if 25% of the cost of the road is borne by the local body, 75% is contributed by state PWD.

# ROADS AND LINKAGE SECTOR



Given the amount of money available with the panchayat, the type of road to be built would be a decision variable.

2. Relief programmes during famine, floods etc., lead to availability of labour to build or improve roads.

3. Octroi levies, restriction on inter district movement of food grains, restriction in interstate movement of trucks, etc. inhibit the growth and use of roads. These can be altered or removed.

For diagramatic representation of the above analysis see fig. 11.4.

## D. Education Sector Linkages

The level variables in the education sector in our model are:

1. Percentage of primary school age population enrolled in primary schools.
2. Percentage of secondary school age population enrolled in secondary schools.
3. Percentage of population literate (a) male (b) female.
4. Enrolment in Adult Literacy Centres.

A. Levels in the education sector are influenced by the following factors:

1. Physical facilities: These are considered in relation to the student population and include classrooms, furniture, text books, games, library, etc.

Adequacy or abundance of these facilities as a ratio with student population denotes a greater than 1 multiplier to the developmental effect of education.

2. Availability of teachers: This is again denoted in terms of teacher student ratio. A higher ratio is considered to lead to better effectiveness of education.

3. Distance from school: Great deal of travelling to be done in getting to school and coming back is a disincentive to enrol. This is true particularly in the case of girls, where the parents do not like to send their daughters to school if it is not within the boundary of the village.

Good roads and convenient transport facility tends to negate the effect of greater distances.

This factor has been quantified in terms of percentage of student population having to travel greater than a specified distance to get to school.

4. Relevance of curriculum: Education provides a greater impetus to development if the emphasis is on vocation oriented curriculum. Education is more relevant if it takes into account the predominant occupation of the block and the needs of any nearby industry.

5. Health: Health has an indirect effect on education. The only quantifiable measure is absentees because of illness.

6. Cultural factors: It has been found that in regions with higher proportion of scheduled caste population the enrolment levels are lower.

7. Income: Per capita income and cost of education, particularly at the higher levels, determine the inclination of the parents to send children to educational institutions.

8. Current literacy level: We hypothesize that parents with a higher level of education have a greater propensity to send their children to school. This can be generalised to the regional level.

9. Government expenditure: Government expenditure on physical facilities, teachers' salaries and training, incentive programmes like free mid-day meals and text books, has a great effect on levels in the education sector.

B. The impact of education is mostly through second order effects.

Attitudes: Education generates a favourable attitude towards family planning, use of health facilities and adoption of new techniques in agriculture. It also brings awareness of public hygiene as well as political awareness.

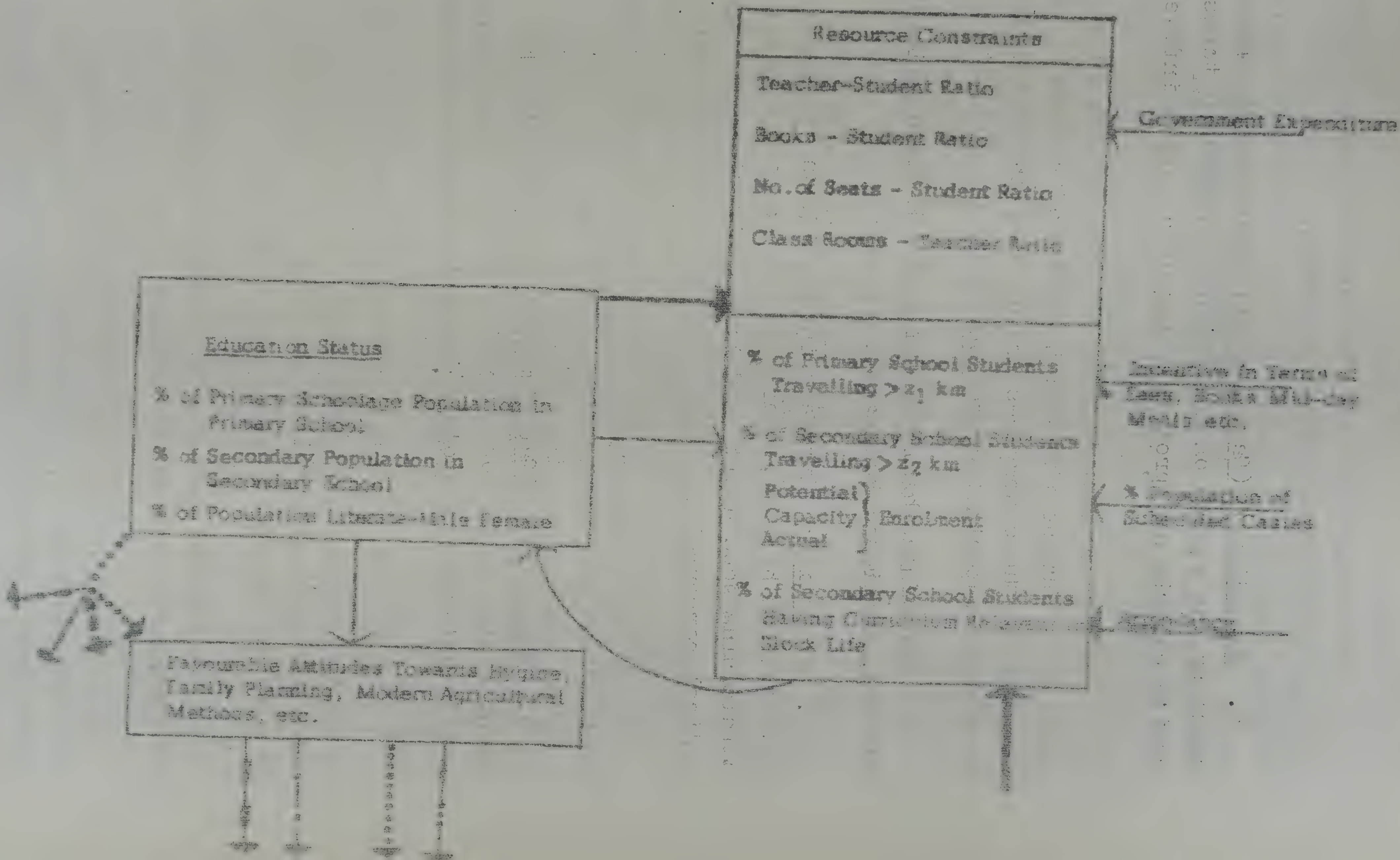
Availability of labour: Vocation oriented education makes various kinds of skilled labour easily available which encourages setting up of industries in the region.

Migration: Education above a certain level results in expectations of a white collar job. Such individuals look down upon manual labour and the result is migration to urban areas.

Dropouts: This is an indication of the educational wastage. This is mainly due to economic reasons which include availability of the required level of education in geographical proximity.

The linkage of education with other sectors is shown in fig. 11.5.

## EDUCATION SECTOR



E. Health Sector Linkages

The health status of a block has been defined, in our model, by means of two parameters:

1. Infant mortality; and
2. Death rate.

A. The factors that affect health status are as follows:

1. Supply of Health Services: The health service personnel are doctors (allopathic, homeopathic, ayurvedic and unani), supported by nurses, midwives, compounders, health workers, family planning workers, vaccinators, etc. which can be grouped under para-medical staff. In addition to the personnel, health services include physical facilities like beds, equipment, drugs, etc.

Simply availability of health services is not sufficient to determine the health status of a block. How effectively these services are used by the local population is also an important criterion.

Use of the health services is influenced by the factors, mentioned below:

2. Education: Literacy in the region determines attitude towards hygiene, awareness of the common rules for maintaining good health and inclination to go to the medical personnel for advice in case of ill-health.

Female literacy in particular has great influence on adoption of family planning ideas.

3. Expenditure (Capacity and preference): The amount spent by the people on nutrition (measured in terms of per capita calorie and protein intake) has great influence on

the health status of the region.

Also to be taken into account is the amount available for spending on drugs and medicine as and when needed.

Both these types of expenditures are dependent on per capita income. Nutrition intake is also dependent upon school feeding programmes sponsored by various agencies.

4. Public hygiene: This is one of the most (if not the most) important determinant of the health status. Proper sewerage and garbage disposable system as well as hygienic drinking water facility contribute towards good health.

Houses served by covered drainage system and local government expenditure on sweepers can be indicators of efficiency of public hygiene system.

5. Connectivity: Easy accessibility of villages by good roads plus the proliferation of health centres to reduce the distance travelled to get to one, contribute towards betterment of health.

Good connectivity also ensures more visits by doctors and health workers as well as mobile dispensary, (if there is any).

6. Government expenditure: Government expenditure on drugs, physical facilities, extension work and special programmes like family planning and school feeding directly influence the health status of the block.

7. Local leadership: Adoption of health services and programmes by the accepted leaders of the region facilitates acceptance among rest of the population.

HEALTH SECTOR

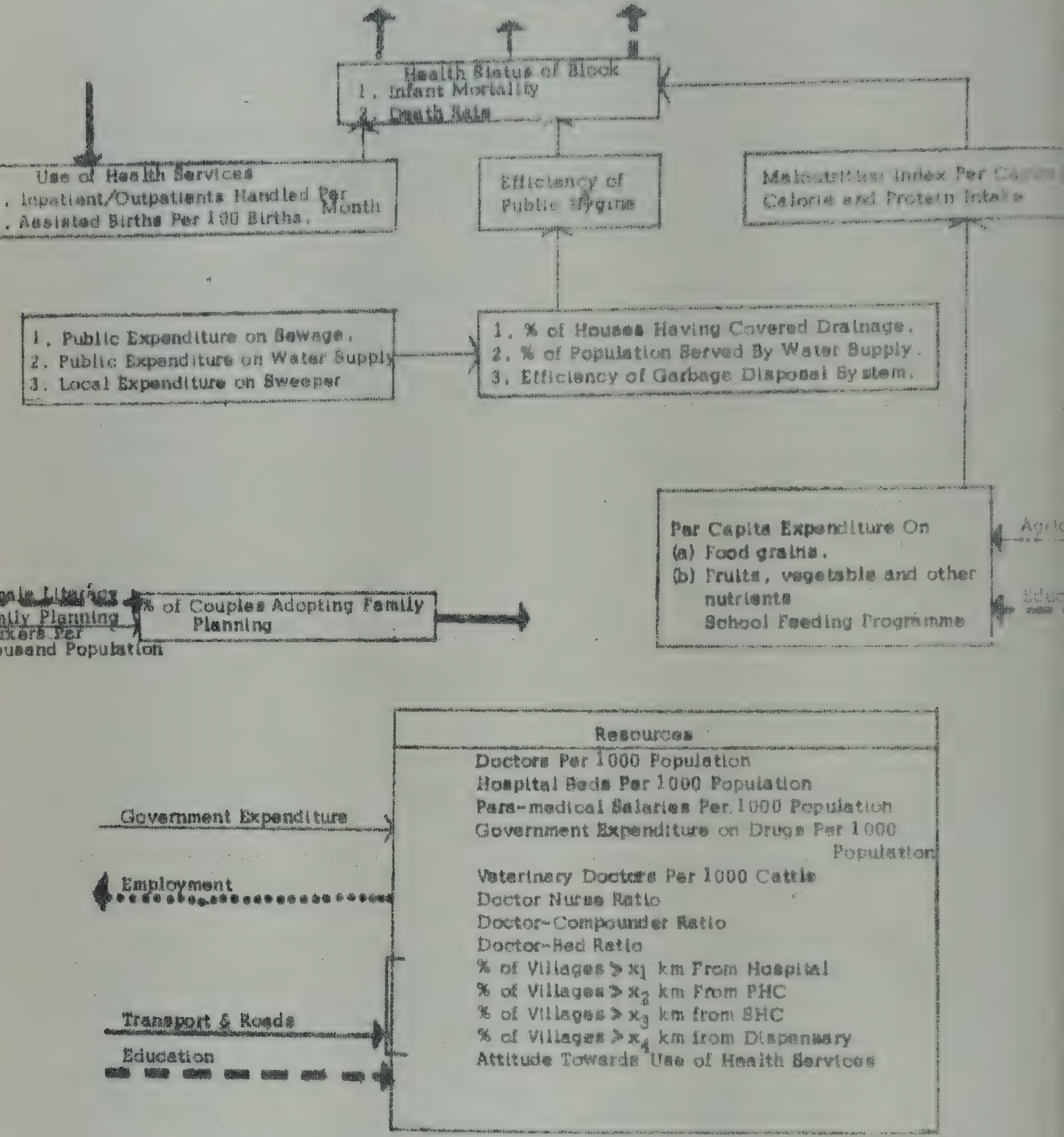



Fig. 11.6

B. Influence of health:

The primary effect of health is on the productivity of labour in agriculture as well as industry, which in turn has a second round effect on per capita income.

Health also affects attendance in educational institutions.

Fig. 11.6 explains the linkages with other sectors.

## F. Rural Administration

The administrative sector impinges on all other sectors directly and with great importance. It has been asserted that good administration can take care of all other weak linkages in any sector. Below we identify first the general model of rural administration which we have used as our paradigm, and then we specify the abstract parameters we will use in the simulation.

A. General model:

The apex of the rural administration hierarchy is at the district level - the collector being the highest administration authority. He has a number of functional specialists supporting him. But here we are confining ourselves to block and lower level administrative machinery.

The block is a unit carved out to facilitate community development work. It is quite possible for a block to coincide with a tehsil in geographical boundaries.

When a block is initially formed it begins a life of eleven years. It receives funds and has a complement of personnel depending on its 'stage' of development. There are three stages - a pre-extension stage in the first year, Stage I in the following five years and Stage II in the final five years.

During the pre-extension stage a few of the personnel are deployed to do initial survey work and start agricultural demonstration in the villages. When the block enters Stage I a period of intensive development ensues. The full complement of community development personnel works to ensure that panchayats, village schools, village cooperatives and statutory organizations at the block and district level are established and begin to function well. During Stage II the responsibility for rural development is gradually handed over to these organizations so that central financial assistance can be withdrawn.

The various functionaries at block level and their involvement with different sectors of the model are as follows:

1. Block Development officer is the controlling authority at the block level and reports to the collector or sometimes to the sub-divisional officer. B.D.O. does not have a specific sectoral responsibility but is responsible for the objectives, methods and contents of the various programmes undertaken. He guides the work of the other staff and is responsible for proper utilisation of funds at his disposal. He is responsible for building up stocks of necessary equipment, for arranging proper storage and maintaining the supply lines.

2. Extension officers: There are generally eight of them - one each for:

| | |
|---|---|
| Agriculture<br>Animal husbandry | Agriculture sector |
| Rural engineering | Agriculture & Road sectors |
| Social education<br>Programme for women & children | Education and Health sectors |

| | |
|---|---|
| Co-operatives | Agriculture & Industry sectors |
| Rural industries | Industry sector |
| Panchayats | Administrative liaison. |

In health sector we have another functionary - the Medical officer at the Primary Health Centre.

They assist and advise the B.D.O. in all matters concerning their specialities. They supply knowledge and data to the village people and various organizations. They try to educate the people in the use of new technology and clear their doubts regarding it. They also help the village people in getting external help or supplies or financial aid.

3. Gram Sevak (Village Level Worker): Gram Sevak is the lowest rung of the administration hierarchy. He is a jack of all trades. His functions include education, information, supply and service, and organization in all the sectors. He reports directly to the B.D.O.

4. Panchayati Raj: There is a parallel administrative machinery in the rural system designated as panchayati raj. The objective here is to bring democratic governing down to the village level.

It is a 3-tiered (Zilla Parishad, Panchayat Samiti, Gram Panchayat) organically linked system. In terms of importance Panchayat Samiti is the linchpin and Zilla Parishad is a mere advisory and co-ordinating body without executive powers (except in Maharashtra - where Zilla Parishad is the executive body).

Zilla Parishad operates at the district level.

5. Panchayat Samiti: It is a statutory body at the block level having a term of 3 to 5 years. It consists of:

i) All the sarpanches of the Panchayats it embraces

ii) Local MLAs

iii) Co-opted members (women, scheduled castes, scheduled tribes).

There might be some other members nominated by the state government or the collector. These members elect a Pradhan from among themselves.

B.D.O. is the chief executive officer for panchayat Samiti and his staff functions under the jurisdiction of the Samiti.

The Panchayat Samiti's activities viz., community development, agriculture and animal husbandry, health and sanitation, education, communications, cooperation, cottage industries etc. cut across all sectoral boundaries.

Samitis approve Panchayats' budgets and provide them supervision and assistance. The concept "fund of political goodwill" as used in our simulation model operates as a breke or accelerator at the stage when programmes require Panchayat Samiti support and popular participation.

6. <u>Gram Panchayats</u>: They are elective statutory bodies at village level. Average number of members in each panchayat is 15 to 20. There is one sarpanch, eight to ten panches, and 3 to 4 co-opted members (women, scheduled castes). Panchayats have functions similar to the samitis. In effect we can say that, Panchayats are field units of panchayat samitis.

<u>Critique</u>:

This description has been of things as they should be. But time and again it has been observed that the administration has failed to deliver the goods.

B. Representation of administration in the simulation:

Based upon various studies, we have identified two critical variables on which efficient implementation of policies depends.

a) Efficient working team: Putting together an effective team involves appropriate selection, rigorous training and motivating factors like good pay and career plans. In the model two parameters have been defined to represent the team performance.

i) Composition of the team: It is defined in terms of numerical strength of the team and its completeness, which denotes whether the team has all the skills needed for implementation.

ii) Efficiency of the team: It depends on the money spent and on the duration of training imparted. It also involves a subjective measure of motivation which can be taken as proportionate to economic rewards.

The interaction of the composition and efficiency gives us a multiplier which acts on the inputs (money, materials) and affects the resultant benefits.

b) Dissemination of information: The rural masses have to be informed and educated for optimum utilisation of facilities already existing and new development schemes.

This process of education is considered to be a draft on the manpower resources or conversely an increase in the quantity of inputs because it requires use of money, manpower (extension workers) and materials. The medium of education can be any combination of mass communication media, extension workers, specialized demonstrations and training programmes.

When the information effectiveness is assessed, it is taken to be a function of the media-mix and the input quantity, imparting information is taken as a multiplier which enhances the benefits accruing from other infra-structural investments and development programmes.

Chapter XII

# SPATIAL INTEGRATION OF AREA DEVELOPMENT PLANS*

## A. What is Spatial Planning?

A realistic planning exercise should have three essential dimensions, i.e., economic, social and spatial. It is not enough to say which sectors should develop and to what extent; what is equally important is to tell who should benefit from the development and to what extent. In other words, planned development should lead not only to an improvement in income measured in average or absolute terms but also to progressive reduction in the disparities in per capita and areal incomes. Wide differences in the earning capacities of urban and rural areas and populations, industrial and agricultural areas and populations, and socially privileged and underprivileged populations must be progressively reduced.

The equity and distributive aspects of planning did not receive the attention, they ought to have, in the early stages of planning largely because of the desire of the developing countries to catch up with the developed countries in economic growth, as fast as possible, and the implicit assumption that economic growth automatically benefits all the people in the long run. Experience of these countries, however, indicates that this need not always be so. In many countries, notwithstanding the high rate of economic growth, disparities in income and production capacities increased because modern technology and production processes tended to favour those who had the

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* This chapter is largely based on a report on Service Centre Planning brought out by Ford Foundation, New Delhi.

intellectual, organizational, and financial capacity to utilise them best. Those who were illiterate, had poor economic base and were slow in adapting themselves to the changing circumstances and modern methods of production benefited least.

Had such underprivileged people been few, the developing countries could ignore them. They could have rationalised this by saying: "the society must pay for economic growth". It however so happens that such people form a large group; in some countries they form a majority. If this group is ignored, national development would have no meaning to them. A small minority would reap the fruits of development; economic differences would widen; social tensions would increase; and the orderly development of the national economy would be jeopardized. It is, therefore important that planning should aim at not only rapid economic growth but also better distribution of the fruits of economic growth inter-personally as well as inter-regionally and areally.

Disparities in socio-economic development manifest themselves in two ways: inter-personal and inter-regional (or inter-areal). Often the two go together. Inhabitants of backward areas are relatively poorer than those of forward areas . Spatial planning attempts to create conditions for the poorer areas and regions to catch up with the richer areas and regions. Where inter-personal disparities in economic and social development are significant, spatial planning is oriented to the poorer sections of the society within the framework of overall areal or regional development goals.

1. <u>Spatial organization</u>:

To understand spatial planning, one should first understand the spatial organization of national economy and human activities. Spatial organization means the functional organisation of a given set of activities in space. We can appreciate this better when we fly at an altitude of, say, 30,000 feet. From that elevation, we see a number of nodes: cities, towns, villages, etc. We see them linked with each other by a network of communication lines radiating from each of the nodes. The networks consist of railways, highways, etc. If we fly at a still lower level, we see more details of the nodes and networks. The larger nodes specialise in activities which are not space consuming such as factories, commercial establishments, etc. The smaller nodes specialize in space-consuming activities such as agriculture, mining, etc. The intermediate nodes such as small towns have a mixed activity pattern. We also notice that network linkages weaken as the size of nodes decreases so that some of the tiny nodes inhabited by a few people and located in resource-poor areas have no or extremely poor linkages.

What binds the various nodes with each other is the network of flow of people, goods and services. Larger nodes attract consumer goods and industrial raw materials. In return, they send out finished products and render a variety of other services to the smaller nodes.

The amount of interaction among various nodes depends on their relative productive capacities and the surplus of goods and income they generate. The nodes which have no surplus have limited inter-action. Those having surplus have relatively more inter-action. The area of interaction of a node is often referred to as hinterland or the zone

of influence. Urban geographers call it urban field.

The networks, the nodal activities and the flows together constitute spatial organization. The spatial organization as seen at a particular time cannot be seen in the same state again. It is always changing. Each birth of a baby, each investment in the factory or farm, each improvement in communication, and each new input in transportation changes the organization. Many of these changes are not perceptible to us because, taken individually they are minute. Cumulatively, they, however force the spatial system to readjust itself to a new situation. New cities come into being; villages are transformed into towns; many communities disappear, small farms become large, crop patterns change and new communication lines give a new pattern of linkages. All this happens in response to the decision of the people to locate themselves and their activities at some, but not other, places.

2. Spatial structure:

The arrangement of nodes networks and associated activities in space in relation to each other is called spatial structure. Each country or region has its own unique spatial structure. It has resulted from the past decisions of individuals and governments. Economically developed countries have one type of spatial structure; the under-developed countries have another type; and those in between have a third type. The typology is, however, not as simple as given above. In fact one can think of a continuum of spatial structures from highly polarized to highly dispersed. Each country or region can be identified on this continuum.

A closer study of the continuum reveals that the highly developed countries have evolved spatial structures which are different from those evolved by the less developed countries. It happens because of the inter-dependence between socio-economic development and spatial structure.

The above analysis leads us to conclude that

a) Planning should be sectoral-cum-spatial;

b) Each country or region has to evolve its own organization and structure of space to meet the specific goals and objectives of planning; and

c) Developing countries with a highly polarized spatial economy have to evolve a spatial structure which difuses the benefits of planned development to those who are poor and underprivileged.

3. <u>Spatial Planning</u>:

Spatial planning is the sum total of the concepts, approaches, methods and techniques of evolving a desired spatial organization and structure. It is often used as co-terminus with regional planning. Theoretically speaking, space is a dynamic and open system. Unlike a region, it has no boundaries. Spatial planning is an exercise to determine the allocation of sectoral resources in places and areas in a way that:

a) Sectoral investments give highest social and economic returns and maximum support to each other;

b) Productive activities and social facilities are available to all those who need and deserve;

c) Differences in incomes and welfare among the people and areas are reduced, if not eliminated; and

x A spatial structure conducive to planned development is evolved.

It may be recalled that spatial organizations and structures of human activities are determined by the nodes, the networks and the flows among the nodes through the networks. The efficiency of a spatial structure depends upon the location, rise and distribution of the nodes, the shape and density of the networks, and the quantity, quality and direction of the flows. The task of spatial planning is to analyse the spatial structures, and to generate structural changes in them to facilitate planned development.

How are the structural changes brought about? To answer this question let us take a hypothetical case of a country which has decided to invest Rs.1,000 million on health services to cover the total population of the country. This country has 10 urban centres and 1000 small villages spread over in space rather randomly. The economic condition of the rural population is rather poor and is based on subsistence agriculture. The links between the urban and rural places are weak and are maintained by a set of intermediaries who collect the surplus rural products in small bits at a subsistence price and transport the same to the urban centres. They also carry the urban products to the tiny villages and sell them at a pre-determined price.

Now the question is: How and where to invest the funds to carry the benefits of health services to the rural population? It is obvious that the health plan should attempt to develop rural health centres with resident doctor and supporting staff. Where should such health centres be built? They should be easily accessible to the people. The spatial planner would develop distance norms or standards and prescribe the number of health centres required to serve all or a maximum number of people. Then he would suggest the vertical linkage between the health centres and better equipped hospitals so that specialized medical service can be secured.

The spatial planner would thus tell: Where to locate these various levels of health services? What norms or standards about distance and population should be adopted? But his problems would not be over with these. If it were only the question of health services, the problem would have been easy. He has to carry out the same exercise for all other sectors such as education, agriculture, commerce, etc. If he decides to locate each facility independent of the other, he would be using the limited resources at so many places and would find it difficult to match the changes in the spatial structure economy with the planned growth of the economy.

Thus one of the important tasks of spatial planning is to integrate the spatially dual economies through successive locational decisions leading to the development of a spatially balanced social and economic structure. The second task is to identify the economic activities, which can be located in space to help fill the gaps in the nodal hierarchy and generate greater flow of goods and services among the places. Thirdly, spatial planning attempts to

evolve a system of transportation and communication network which facilitates the expected flow. And finally, spatial planning specifies the institutional infrastructure including administrative and planning which can help build a well structured space economy.

4. Distance standards for services:

For different services and activities, there should be different distance standards. Establishing distance standards which are realistic in the light of the local and regional conditions is an essential step in spatial planning specially for the rural areas. This must be done for every area or region to be planned with respect to each kind of service or activity which is to figure in the plan.

Let us take the example of education. What is the range of distance from which children can be drawn for primary schooling? One may say, that the school should be located where the children live. But, what to do if the rural settlements are small and none of them can singly provide enough children for the school? Or, if enough resources - financial or human - are not available to provide a primary school to every village? One of the several small villages would have to be selected for provision of school. If the school is so located that most of the children would have to walk for, say 10 km. to reach it, it would not be efficient because the objective is to provide primary education to every child within a walking distance.

India has made primary education compulsory. To make this policy a success, primary education must be accessible to each child of school-going age without impairing the effective functioning of the school, i.e., there are enough

children within a radius set by the planners. Let us say 2 km. radius can be taken as a standard for primary school. If possible, it should be less, but, barring very exceptional situations, it should not exceed 2 km. Now we will call 2 km as the distance standard for primary schools. We would then take up each activity and set distance standards, remembering that within a given activity, say education, we will have to set distance standards for primary, middle, secondary, college, etc. levels separately.

5. Setting population threshold standards:

Along with the distance standard, a population standard has also to be evolved. For each activity, there should be a minimum population in its catchment area carved out by the distance standard. For example, a primary school should have at least 100 children, i.e., 25 children in each class. If we take 15 per cent of the population being in the age group of 6-11, and if we assume that every child in the primary school age-group should or would attend school, there should be at least 800 persons in the catchment area of the school. The required population will increase, as the strength of the school in terms of children enrolled increases. Thus we arrive at a population standard.

6. Conflict between distance and population standards:

After distance and population standards are set for different levels of each activity, the two should be empirically tested to determine their applicability to different situations. Population density in some areas or regions may be so low that sufficient number of people may not live within the distance standard to make the offering of a particular service feasible. Or there may be too many people within the radius of the standard distance. In such

circumstances, necessary adjustments would have to be made between the conflicting standards. The nature of this compromise will depend upon considerations such as future development possibilities, possibility of improving transport impediments, possibility of providing mobile service, even on a selective basis, etc.

The conflict between distance and population standards raisesthe question of equity <u>versus</u> efficiency in spatial planning. If equity expressed as a maximum travel distance, is the governing factor, then the efficiency question is: What is the minimum number of places required to put all places in the area of operation within that distance of a centre and where should the services be located? If efficiency governs in terms of minimum population base, then the equity question is: - Where should a given number of services be located so that the maximum level distance from all the places selected to the most remote villages they serve is least but that around each place the minimum number of people necessary to support the facilities are present? Spatial planner has to resolve these conflicts.

7. <u>Setting the hierarchy of services and activities</u>:

Another problem that the planners have to give attention to in spatial planning is the hierarchy of services and activities. Certain services are needed by the people too frequently to be located at long distance; e.g., primary school, health clinic, extension agent, grocery store, agricultural marketing. Some are not needed so frequently such as specialized hospitals, colleges, wholesale market, etc. When we set the distance and population standards for various services and activities, we have to keep the hierarchy of services and activities in view.

It is therefore, important that the services and activities to be located to meet the equity and efficiency criteria are classified and standards for each class are worked out.

Each class of the educational service mentioned above requires a separate set of standards. It should be emphasized here that the classification mentioned above is illustrative. For each country and region, different hierarchies would have to be worked out for each service.

## B. Constructing the Hierarchy of Settlements and Services

An important problem in spatial planning is the determination and construction of a hierarchy of settlements which can provide an efficient framework for location planning. By hierarchy of settlements, we mean the order in which settlements stand with respect to each other in terms of population and activity. An idealized settlement hierarchy tree is illustrated in figure 12.1. In this figure, the first level settlement is the most important settlement. In its area of influence, there can be several second level settlements (for want of space, only one is shown here). There are six settlements of third level and each of these has several settlements in the area of its influence.

The hierarchic ordering of settlements presupposes that higher the place of a settlement in the hierarchy, the higher the levels of functions or activities located there. It also presupposes that the functions present in a place of lower order, would be present in places of next higher order. For example, if there is a primary school in the lowest order settlement, there would be primary schools in all settlements of third, second and first orders. Starting from the top, if the first order has a hospital, the

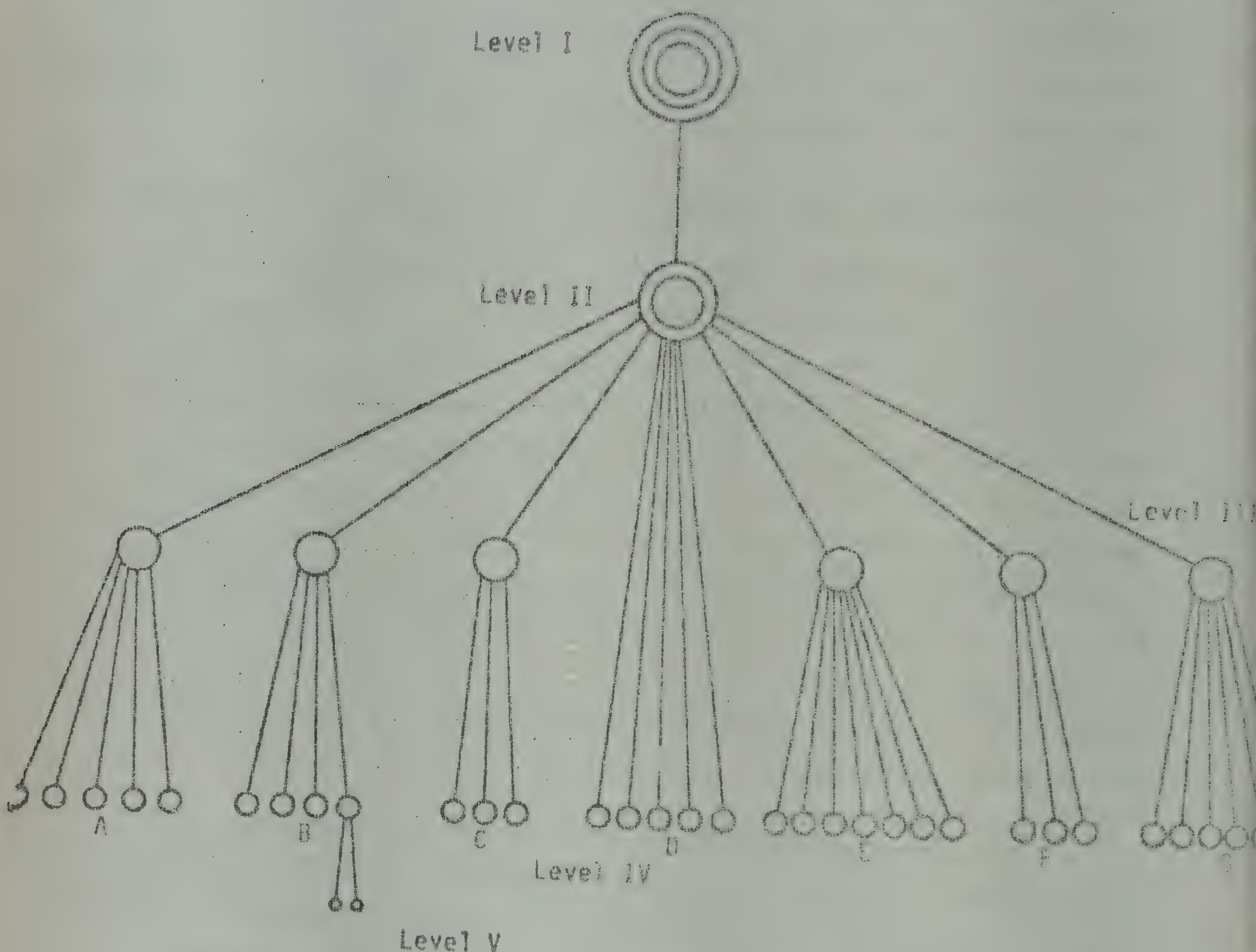



**Fig. 12.1** IDEAL HIERARCHICAL SETTLEMENT ORGANIZATION TREE STRUCTURE.

second order may have a health centre, the third order, a small clinic and the fourth order, only a health visitor.

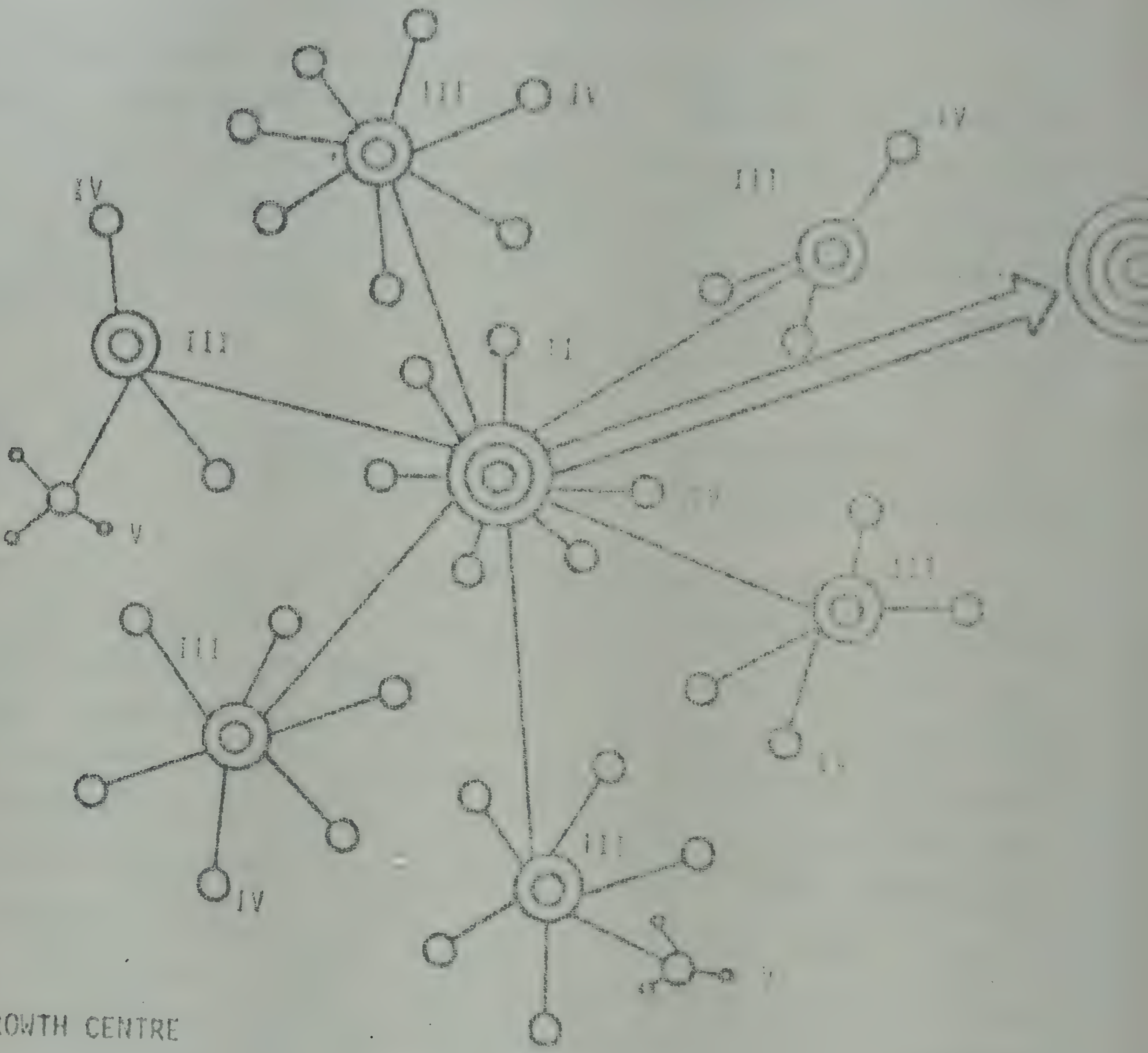
The hierarchy is based on the size of population. It can also be based on the number and the levels of functions. The first level would ordinarily have largest population. It would also have the highest levels of various functions. Thus the order of a settlement in the hierarchy is indicative of the level of services and activities it has or should have.

At this point, one may ask the question: Why construct the hierarchy? Why is it important?

The answer is rather simple. We do not construct hierarchy. Hierarchy of settlements is already there. We only identify what already exists and give a scientific base for it and then use it for planning purposes. Some human activities are space consuming. Agriculture is the most important among them. Such activities are generally dispersed. Most other activities are not space consuming to the extent agriculture is. These activities produce goods in large quantities or they serve a large number of people. Such activities are localized at few places. For example, steel plants have to be located only at a few places; similarly, a large specialized hospital or a wholesale market has to be located only at a few places. But a small clinic or a retail shop can be located at several places. So the hierarchy in human activities already exists. This together with the population, gives rise to the hierarchy of settlements.

An ideal hierarchy of settlements is given in fig. 12.1. When we put it horizontally, we get a picture as

Fig. 12.2 : AN IDEALIZED SYSTEM OF SETTLEMENTS FOR RURAL AREAS CORRESPONDING TO FIGURE 1.




I. GROWTH CENTRE

II. GROWTH POINT

III. SERVICE CENTRE

IV. SUBSIDIARY SERVICE CENTRE
(CENTRAL VILLAGE)

V. VILLAGES

given in fig. 12.2. In these figures, the second level centre serves six smaller centres, let us say small towns. And each of the small towns, serve so many villages. The people meet their primary needs in the villages, for secondary needs they go to third level centres; for tertiary needs, to the second level centre, and for the most infrequent quarternery needs, to the first level centre.

Now, let us consider a situation in which the third level centres do not exist. People would either go to the second level centre or they would remain deprived of the secondary needs. An inefficient hierarchy of settlements has missing gaps like this. Spatial planning attempts to fill the gaps.

1. Population as a centrality index:

The role, a particular place plays in relation to other places as a centre of services, facilities, goods and social interaction, is referred to as centrality. The indicator of the centrality is called centrality index. Centrality and thus the hierarchical rank of a given settlement in a region is a function of its development. The simplest method is to take population as an index assuming that its magnitude correlates well with its development.

After noting down the population of each settlement of the area under study, the settlements may be grouped together for typological purposes using one or the other criterion of grouping. The census classification of towns is based on this principle. We, however, find certain problems with this type of classification. We do not take into account the functions, the settlements falling in each category perform. Two places with same or approximately same population may not be equally important. One may have

several service functions to serve a large population living in surrounding villages. The other may be just a subsistence farming community with none or much lower level of functions.

In spatial planning we therefore rarely take population alone as the criterion for constructing settlement hierarchy.

2. Institutional scalogram:

Another method of arriving at a centrality score is derived from Guttman Scalogram technique. This method uses the presence or absence of institutions providing services, economic activities, etc., as the criterion for classification. This method is superior to the first one, specially when the objective of the exercise is to select places which can provide various services to the rural population within a given range of distance. But in a situation where institutional information is not readily available, the first method (population) can be used as a basis for constructing hierarchy of settlements.

The methodology for constructing a scalogram is as follows:

Step 1: Using a large sheet of paper, list all the settlements in order of their population on the left hand side and list all the institutional facilities of significance in a row at the top. Significant institutions are those which are found in various settlements and are permanently located. The format is given in fig. 12.3, which refers to a scalogram prepared for Kazerun Shahrestan of Iran.

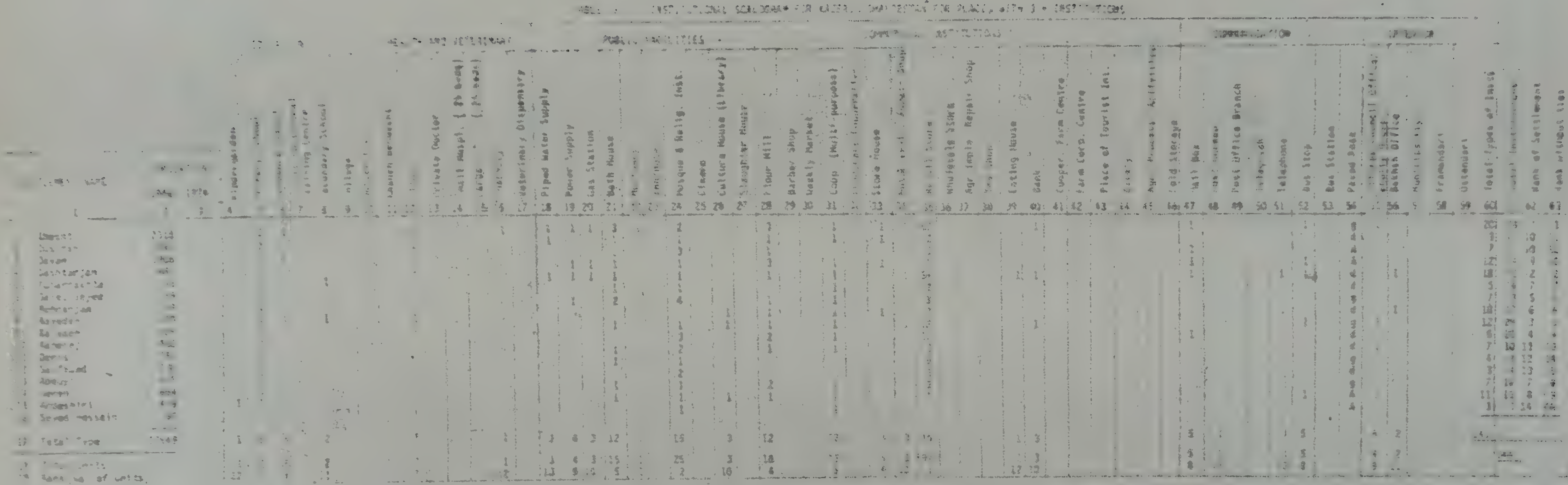

Piped Water Supply
Power Supply
Gas Station
Bath House
Mosque & Relig. Inst.
Cinema
Culture House (Library)
Slaughter House
Flour Mill
Barber Shop
Weekly Market
Coop (Multi-purpose)
Store House
Wholesale Store
Agr Imple. Repair Shop
Eating House
Bank
Cooper. Farm Centre
Farm Corp. Centre
Place of Tourist Int.
Cold Storage
Mail Box
Post Office Branch
Telegraph
Telephone
Bus Stop
Bus Station
Patrol Post
Bakhsh Office
Farmandari
Ostandari
Total Types of Inst.
Rank of Settlement
Total

Fig. 12.3

Step 2: Write down for each settlement the number of institutions present in the appropriate column.

Step 3: After step 2 is completed, sum the types of institutions and number of different institutions regardless of type for each settlement. In our example (Fig.12.3) total number of types of institutions in **Zheaht** is 20 and the total number of units of all institutions is 78.

Step 4: At the bottom of the table give the number of places having each type of institution in the appropriate column. And below this row give the total number of units of each institution in each column. For illustration see fig. 12.3.

Step 5: In the extreme right hand side of the table rank all settlements in order of the total number of units of various institutions given in the preceding column. The place with the highest number gets first rank. At the bottom of the table rank all the institutions in ascending order. The institution with largest number of units in all the settlements gets first rank. When all five steps have been completed, first stage in the construction of the scalogram is over. One can treat this as final or go to the next step. It is optional. Before we go to the next stage, let us return to step 5. What happens when two places get the same rank on the basis of the number of units that the institutions present? In such case we look at the population column. The settlement with larger

population gets the superior rank. This is one way to break the tie.

Step 6: After completing the ranking of settlements and institutions, as stated above, the institutional scalogram for the area will show circles around the number and types of institutions. A pattern of hierarchy can be visually seen from this. Now re-order the settlements in column one of the table, so that least number of holes (zeros) appear in row of the first settlement. The number of holes (zeros) will increase as one moves to the second, third and so on settlements. This shows the hierarchy of settlements much better.

Step 7: Repeat step 6 for institutions also. Add the number of settlements having each type of institution. Write this at the bottom of the column. Next add the units of each institution present in each of the settlements and write below in another row. In the last row, rank the institutions. The first rank goes to the institution having largest number of units in all the settlements. This institution is needed most.

When all these steps are completed, the institutional scalogram is ready. It gives the hierarchy of the settlements, as well as the hierarchy of institutions. We interpret the scalogram in following way:

a. The higher level settlements have lower demand for institutions which get higher score in the ranking.

b. The lower level settlements such as villages have higher demand for institutions which get higher score in the ranking.

c. The institutions getting higher ranks are those which people need closer to their place of residence.

d. The institutions getting lower ranks are those which are less frequently needed and hence can be located at longer distances.

If we decide to evolve a three tier hierarchy of places for rural development, we should be able to select the places which can qualify for each of these levels using the rank of settlements. The rank gives candidate settlements for rural choice. The actual choice will be made after taking the distance standard for each service and activity incorporated in the scalogram and the population of the area to be served.

3. <u>Uses of hierarchical organization</u>:

To this point, the concern has been to find spatial patterns of centres that can satisfy a given distance or other standards. In addition to the compromises often required to reconcile conflicting standards for a particular activity, a second kind of compromise is often required when different activities with different standards are to be located in the same area with the proviso that the locations for one activity should be chosen from the centres in which the other activity is to be located. This "hierarchical" organisation of activities has the following advantages:

a. It is convenient and efficient for the consumer because it enables the satisfaction of several

different needs on the same trip out of a village;

b. It reduces the amount of public transportation required to connect villages to facilities because, from among the many possible transport links between places, those few links connecting villages to their local service centre and connecting the service centres to more important places will be recognized by all to be the priority links where public transportation facilities should be provided;

c. It reduces the length of roads that require improvement before every village is connected to places having facilities to which they need access;

d. It economizes on the cost of providing services to the facilities themselves because these costs can often be shared among several facilities located in the same place. The cost, for example, of providing banking services to facilities is obviously reduced if they are grouped together in few places rather than scattered among many;

e. It enables a more economical and effective monitoring of the regulated activities;

f. It facilitates the exchange of information and qualified personnel between related activities.

g. It focusses the development efforts for a region on a few places with superior locations and resources and this increases the

likelihood that some of the places will spontaneously generate additional activities catering to the needs of their hinterland region.

The disadvantages of such a hierarchical organisation of activities is that the distance standards and other requirements of individual activities must be adjusted and grouped at discrete levels. Frequently, individual standards must either be stretched to fit into the level of places or shortened to fit into a lower level set of places. In the first case, the maximum distance of villages from their closest centres with the required activity may be unacceptably long and, in the second case, the number of facilities that would be required might be more than investment funds permit or that can economically exist.

## C. Graphical Methods of Service Centre Planning: Circle Method

In this section we propose to demonstrate one of the two graphical methods of selecting various levels of service centres from amongst the several candidate settlements which qualify for selection. We get the qualified candidate settlements from a scalogram.

Step 1:

Prepare at least ten copies of a working map of the area of planning extended in all directions beyond its boundaries to include settlements of 500 or more population located within a distance approximately equal to its diameter in that direction. Fig. 12.1 and notes provided with it illustrate a method for preparing this map. Unless the area is extremely long in one or more directions the map should be prepared on a scale of 1:200,000. All maps

Fig. 12.4: WORKING MAP OF A HYPOTHETICAL STUDY AREA


[illegible] for Preparing Working Map of the Study area

Identity boundary (______) [illegible] the area [illegible]
[illegible] a distance approximately equal to the block's diameter in a variety of di[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
**area** [illegible] in terms of centrality (e.g., settlements a,[illegible],f,g, [illegible]
equal to or surpass settlement d in importance).
[illegible]
identified in step [illegible] (e.g., settlement [illegible]
[illegible] other settlements of 500 or more identified in step [illegible]

should show the transportation system, settlements and major features such as rivers, slopes, forests, lakes, swamps, canals, etc. The exact locations of settlements having latest populations of more than 500 are crucial; those having smaller populations may be approximate. It is preferable to show all settlements located in the planning area, big or small, irrespective of population size. But outside the planning area, only settlements with 500 + population need to be marked.

Step 2:

Prepare a list of all settlements shown on the map ranked in the order of their latest populations. In three adjoining columns note the actual population of each settlement, the number of types of institutions in the attached list of institutions found in each settlement, and the number of units of these institutions in each settlement. Column four need only be completed for settlements having more than 500 population. A format for recording of these data is suggested by Table 12-1.

Table 12-1: Settlement populations and numbers of institutions.

| Settlement Name (Census Code) | Population | Number of Types of Institutions | Number of Units of Institutions | Rank |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| | | | | |

Source: Columns 1 and 2 should be filled from the Census Handbook.

Column 3 refers to numbers of institutions represented by at least one unit in each settlement that appear on the attached List of Institutions (Table 12-2).

(Continued bottom of p.310).

Table 12-2: Illustrative checklist of institutions

Kindergarten
Primary school
Middle school
Higher Secondary school
Arts/Science college
Technical college
[illegible]ersity
Dr[illegible]ing water wells
Drinking water (piped)
Consumers cooperative stores
New cooperative
Producers cooperative
Warehouse
Rural market
Petrol pump
Agricultural implement repair shop
Veterinary hospital
Bank
Retail shop
Wholesale shop
Hardware shop
Restaurant/Hotel
Library
Health centre (clinic)
Private doctor
Hospital
Agro-processing industry.

Note: The list may be altered wherever local conditions and/or available data suggest that doing so will result in a list that includes institutions which are more indicative of potential for economic and social development.

Step 3:

Prepare a working sheet with the format of Table 12-3. Most of significant information for the Service Centre Plan will be recorded on this working sheet.

Table 12-3: Working sheet for derivation of service-centre levels in the planning area:

| Standards for Maximum Travel distance | Number of centres required | Median population of service areas | Typical facilities and services required |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| | | | |

Sources: Column 1 from steps 4 and 5,
Columns 2 and 3 from step 6 and iterations of steps 7 and 8, and
Column 4 from step 9.

Step 4:

First determine the highest standard for maximum travel distance that is reasonable for the given area level planning. Perhaps this is prescribed in public policy. If not, by inspection of the Working

Cont'd from p.308: Table 12.1 Source.

Column 5 is the order of entries in Column 4. Ties should be broken by comparing total numbers of institutional units in each set of settlements having identical entries in Column 4. Ties that still remain should be broken by comparing populations.

Column 4 refers to the total number of institutional units in each settlement having a population of 500 or more (e.g., 2 retail shops plus 1 high school plus 2 elementary schools equals 5 units).

Note: The data for Columns 4 and 5 would be derived from institutional scalogram.

Map of the study area, identify the settlement which are most remote from the centres in the study area that were selected in step 1-d. In the example provided by fig.12.4 such a settlement or settlements will probably be found at the north-western corner of the area roughly two inches from settlement d. The crow-flight distance of the most remote settlement or settlements from the nearest two (or, in this example, three) such centres should be rounded off to the closest even number and recorded as the first entry in column 1. No settlement in the area is much farther from step 1-d - selected centre in the study area than this distance.

Step 5:

Now complete the rows of column 1 with a downward progression of fours from the first entry to twenty or eighteen (if any) and of twos to two kilometers. For example, if the first entry recorded in step 4 is twenty-six kilometres, column 1 would be as follows: 26, 22, 18, 16, 14, 12, 10, 8, 6, 4, 2.

Step 6:

The next series of steps is to determine entries for column 2 and then column 3 for successively lower rows, using one Working Map identified by the title "Service Centre Plan for a Travel Standard of X kilometres" for each. If there are eleven rows in the working sheet, there will be eleven Working Maps and these may be titled now.

Begin by considering the first row and Working Map. Take a compass and draw circles on the Map centred on the centres identified in step 1-d within the planning area which have radii equal to the distance standard recorded in step 4 (the greatest standard). Then record in column 2

the number of such centres in the planning area and, in parentheses, those outside the planning area, but in the study area. In the example provided by fig. this is 1 (2), the number of centres required in the study area, in order to place all settlements in the planning area within the highest maximum travel distance standard of at least one centre.

Step 7:

Now partition the planning area by drawing lines which connect the intersections of all parts of circles just drawn so that all settlements will be assigned to their nearest centre. For example:

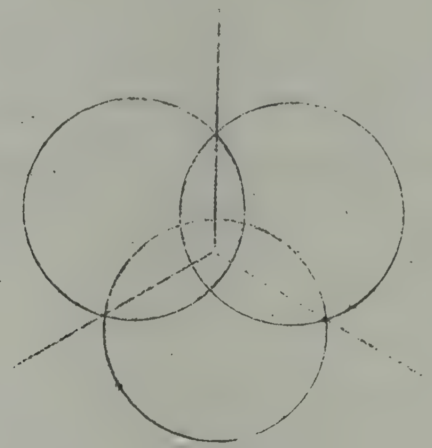


fig. 12.5: Assignment of settlements to nearest centre.

Step 8:

An entry for column 3 may now be determined in the following manner:

a) identify those partitioned areas which lie substantially in the study area;

b) list all settlements within each such area along with their populations provided already in Table 12.1;

c) add up the populations of settlements in each such area - these are the service area population

of each centre at this level of travel standard;

d) list the centres of each and their total service-area populations in d scending order of the populations;

e) identify the median service-area population - if the number of centres is odd this is the middle one and if it is even this is the average of the two in the middle; and

f) record this median in the first row of column 3.

Step 9:

After entries have been provided for columns two and three for row one proceed to row two. Take the Working Map titled with the distance standard appearing in column one of this row, adjust the compass to this distance, and draw circles of that size on this Working Map around each centre marked on the first Working map. These circles will include settlements which are within the lower distance standard of centres already chosen and exclude those which can be served at this standard only by adding one or more new centres. If the excluded settlements are either insignificant or extremely close to a circle edge, ignore this travel standard and move on to consider the next lower row of the Working Sheet and its corresponding Working Map.

If the excluded settlements are deserving of one or more new service centres, the problem is now to locate such a centre or centres. Do so by taking one or more circle templates equal in size to the circles just drawn, generally one for each subregion of excluded settlements. Move these templates over the sub-regions and fix their centres on settlements having the highest ranks in terms

of population and/or institutions recorded in the table showing institutional scalogram (fig. 12.3) which are located in such a way that all significant settlements are now included (or very nearly included) in a circle. These new centres may be located within the uncovered subregions, adjacent to them, or even outside the planning area. As few new centres as possible should be introduced, generally, and thought should be given to centres which will be required anyway for lower distance standards. When all templates are fixed - i.e., when all significant subregions are covered - draw the new circles on the second Working Map and record the total number of centres inside and outside the shahrestan in column 2. Then determine the median population of service areas at this level in the manner suggested in step 7 and record this in column 3.

Step 10:

Repeat this procedure for each sequentially lower row of the working sheet.

Consider as many examples of public and private facilities and services as you can in terms of criteria suggested by entries in columns 1 (maximum travel distance), 2 (number of centres in the planning area) and 3 (median population served by a centre). From among these facilities and services select those for which reasonable standards are suggested by entries in columns 1, 2 and 3, and record these in column 4. Try when possible to cluster them in certain rows of the Working Sheet. The objective of this exercise is to identify a small number of spatial levels through which goods and services may be supplied most efficiently and equitably in the planning area.(Those for which entries appearing in columns 1, 2 and 3 are too low should not be recorded here since they are probably subjects for higher-level planning).

The entries recorded in column 4 of the Working Sheet will ideally be clustered in a small number of rows - say four or five. If so, they may be interpreted as indicators that the corresponding maximum travel distance, numbers of centres required and median service-area populations define meaningful levels of spatial hierarchy in the planning area. Tables 12-2 and 3 (the Working Sheet) and the Working Maps corresponding to levels chosen in step 9 can now be used to complete Table 12-4. This is a summary of key data for the planning area's service centre plan. Final versions of the Working Maps constitute the plan itself, but these data will become useful whenever it is used.

Table 12-4: Service centre plan for summary of key data

| | Level I | | | Level II | | | Level III etc. |
|---|---|---|---|---|---|---|---|
| Centre Name | Max. Travel Distance | Population of centre | Population of Service area | Max. Travel Distance | Population of centre | Population of service area | |
| | | | | | | | |

Application of the method to a hypothetical area is shown in figs. 12.6 to 12.8.

## D. Graphical Method of Service Centre Planning: Bi-Section Method

The circle method is easier to follow but is less efficient in many ways specially when the geography of the area is too complex. In this section, we give the outline of another manual method with hypothetical

Fig. 12.6

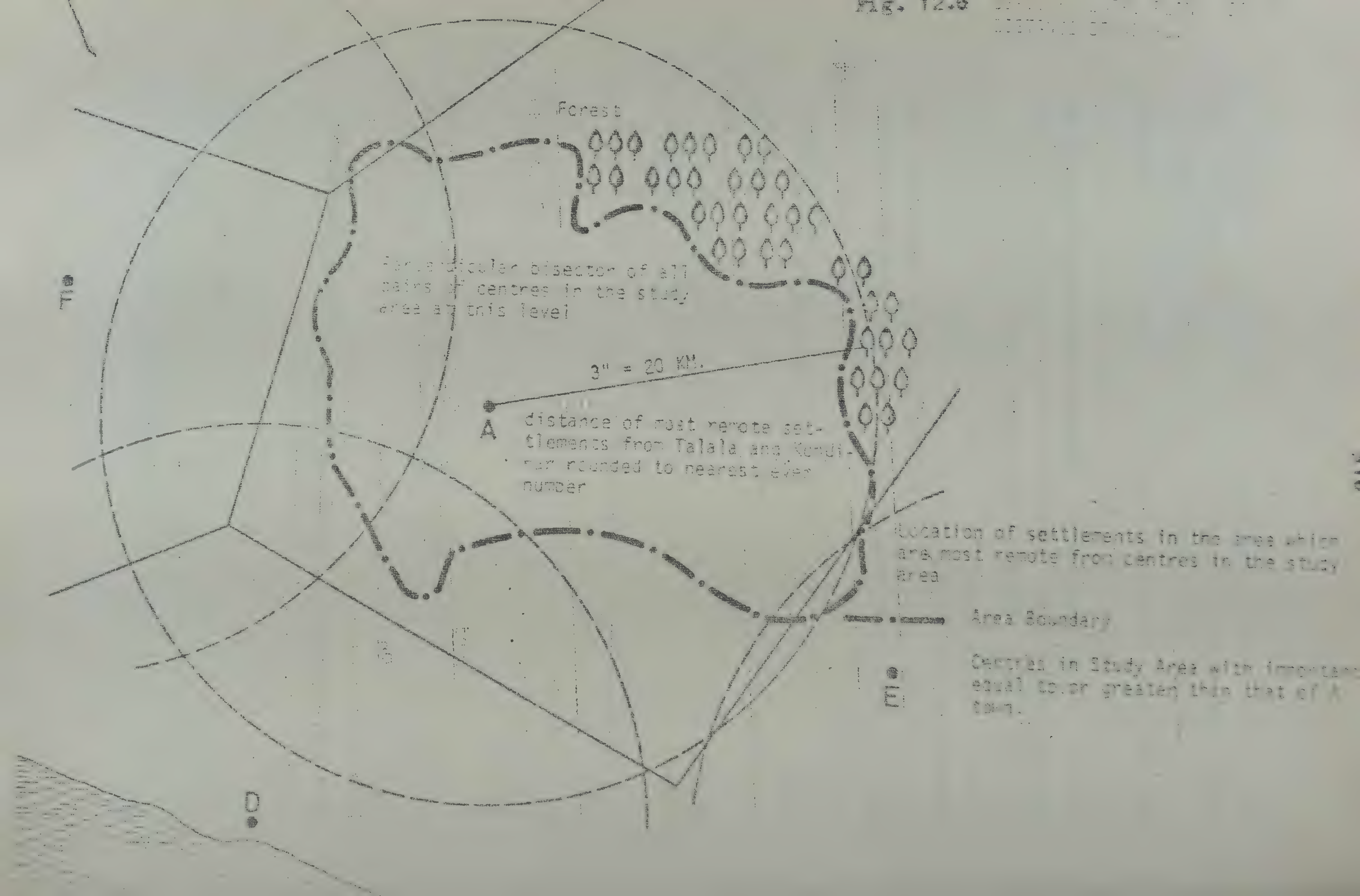

Forest
Perpendicular bisector of all pairs of centres in the study area at this level
3" = 20 KM.
A
distance of most remote settlements from Talala and Kondi-nar rounded to nearest even number
Location of settlements in the area which are most remote from centres in the study area
Area Boundary
Centres in Study Area with importance equal to or greater than that of A town.
E
D
F

Fig. 12.7 SERVICE CENTRE PLAN: 10 KM DISTANCE STANDARD

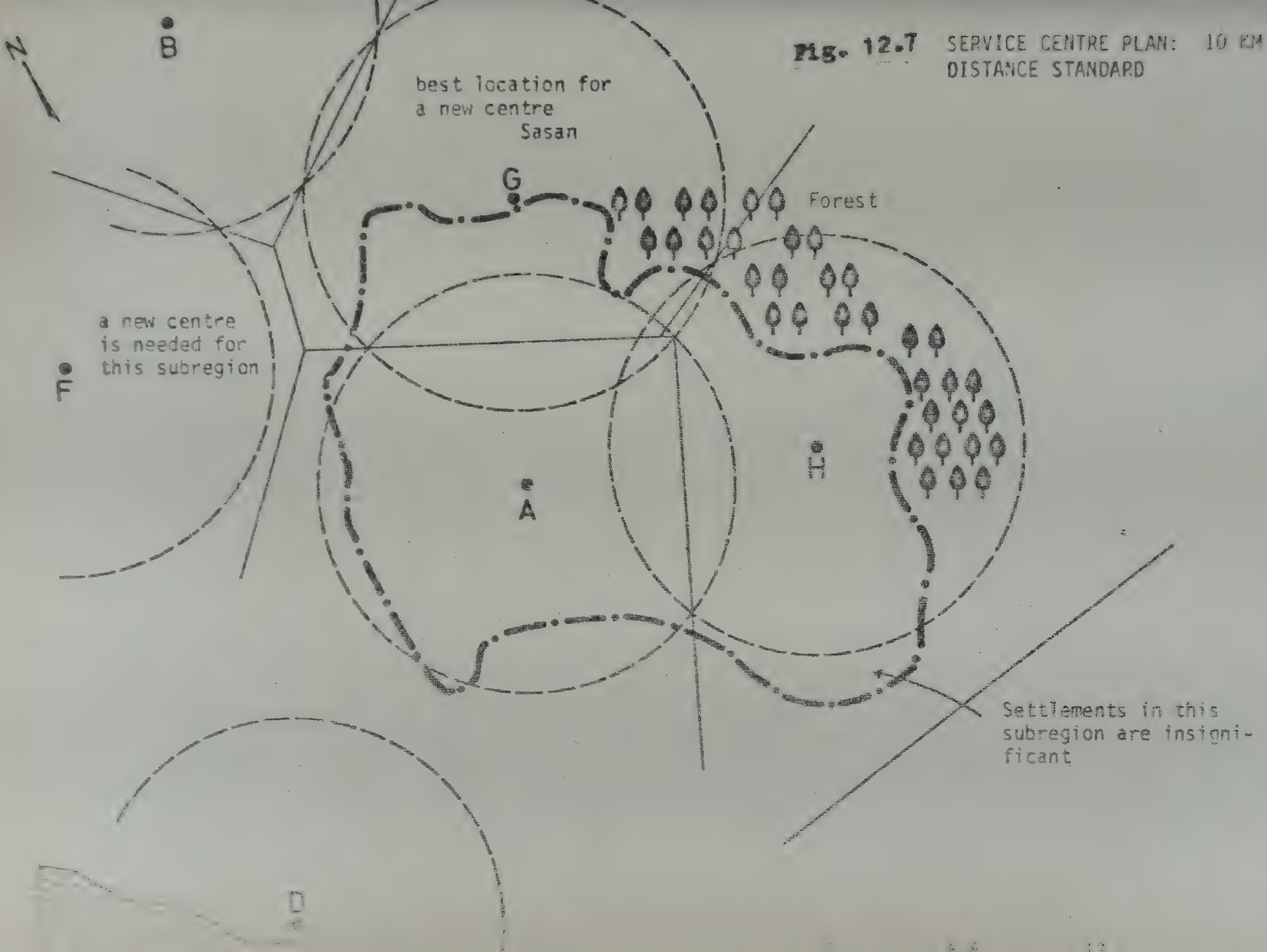
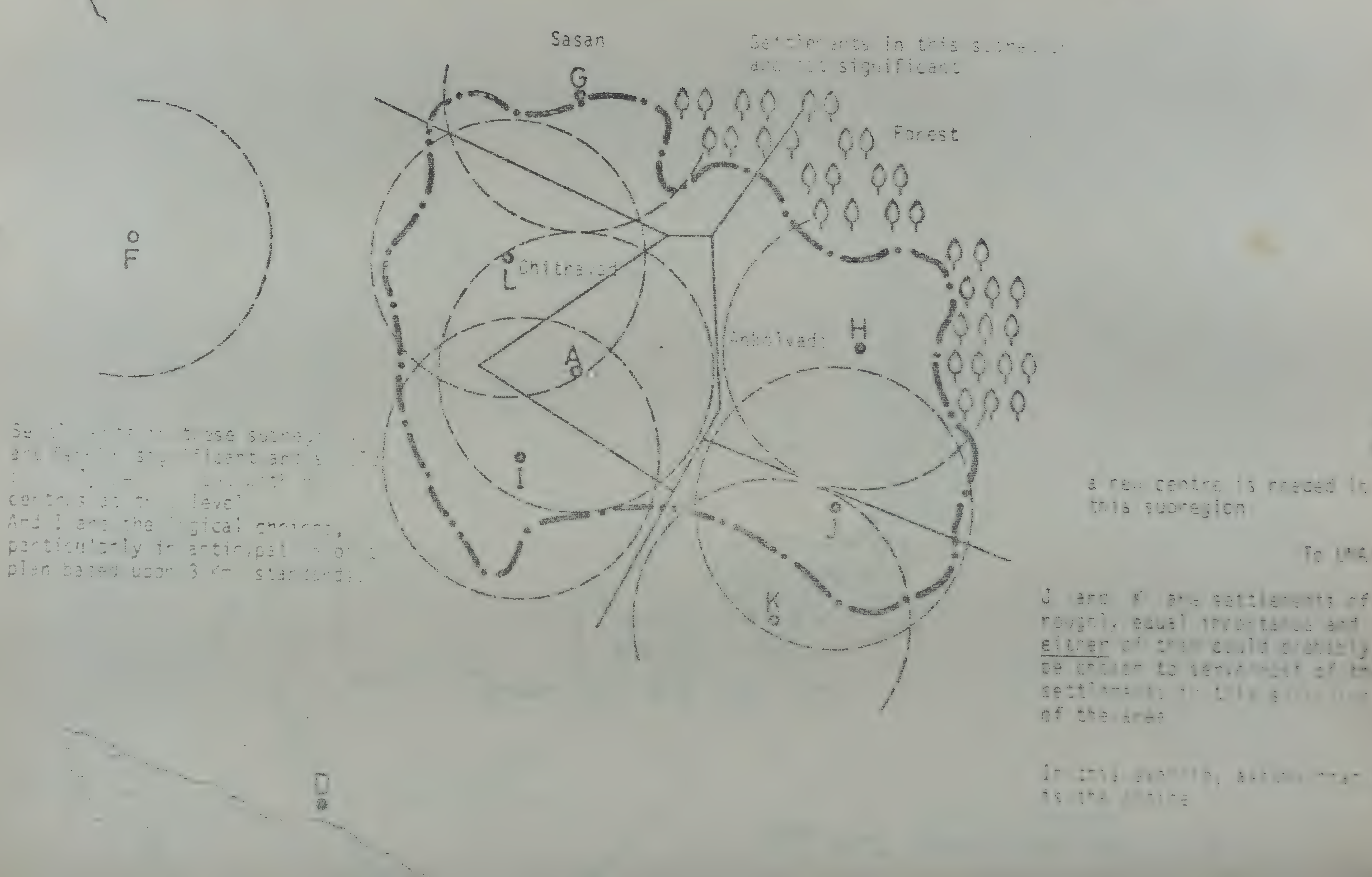


Fig. 12.8



examples. It may be mentioned here that the terminology used here is more specific than the one used in section C. <u>Growth point</u> is the highest level Rural Service Centre, <u>Service centre</u>, the intermediate level, and the <u>central village</u>, the lowest level. Villages not covered by these, are too small to qualify for the location of the services and activities of any consequence either on the basis of distance or population standard.

| | |
|---|---|
| Steps 1 and 2: | These steps are identical to steps 1 and 2 of the circle method. |
| Step 3: | Take the most important place or places in the planning area. |
| Step 4: | Search for other places - in all directions - inside or outside of the area that are of approximately equal or of greater importance. This judgement should be made on the basis of number of institutions and population sizes. It is not necessary to search beyond the area boundary at distances larger than the approximate diameter of the planning area. |
| Step 5: | Draw lines from this most important place(s) to the neighbouring places identified in (ii) above. (Follow transport routes if the places are connected by reasonably direct links, otherwise the straight lines); |
| Step 6: | Bisect each of these lines and construct perpendicular lines at these points of bisection; |

Step 7: The innermost area formed by the intersection of these perpendicular bisectors is an approximate delineation of the area that will be served from the most important centre(s) with the services and goods which are not offered by next lower level centres. Other areas will be served by other centres;

Step 8: Search the area around the boundary line of this area, identifying the places of local importance in this region. These places will normally have a higher level of institutional development than the average village, indicating thus that they are already performing some service functions for neighbouring villages.

Step 9: Select next lower level centres from among these places so that they are distributed approximately uniformly around this boundary region. These will function as lesser order service places.

In selecting these centres consider the three types of patterns shown in figs. 12.9 to 12.13 to guide the search for appropriate service centres. Using the above method, central villages can also be identified (fig. 12.14 to 12.16).

**Fig. 12.9** SELECTION OF SERVICE CENTRES:
HYPOTHETICAL AREA

Step 1: Choose the growth points inside and outside the area. Erect perpendicular bisectors from the lines joining the major centre in the area to its neighbouring centres.

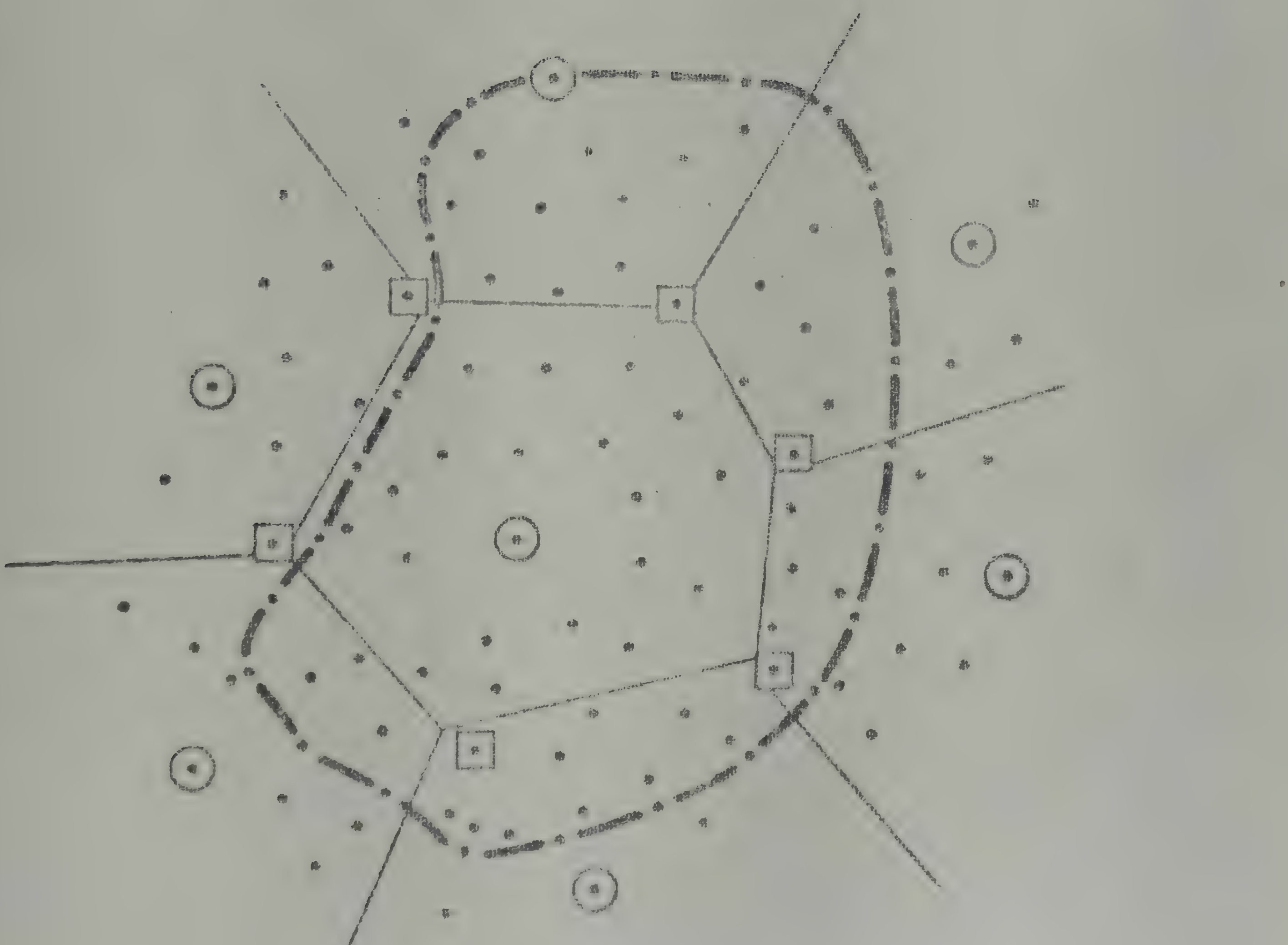
Fig. 12.10 SELECTION OF SERVICE CENTRES

Step 2: Choose service centres in t
region of the boundaries between th
growth points.

Planning Model A: In this model the
sidiary centres are located along th
edges of the boundaries between the
points.

Fig. 12.11 SELECTION OF SERVICE CENTRES

Step 2 Planning Model B: In this model the service centres are located at the corners of the boundaries around the growth points.



Legend: Area boundary

Growth points

Service centres

Fig. 12.12 SELECTION OF SERVICE CENTRES

Step 2: Planning Model C: In this model the service centr
are located on either side of t
boundaries between the growth p

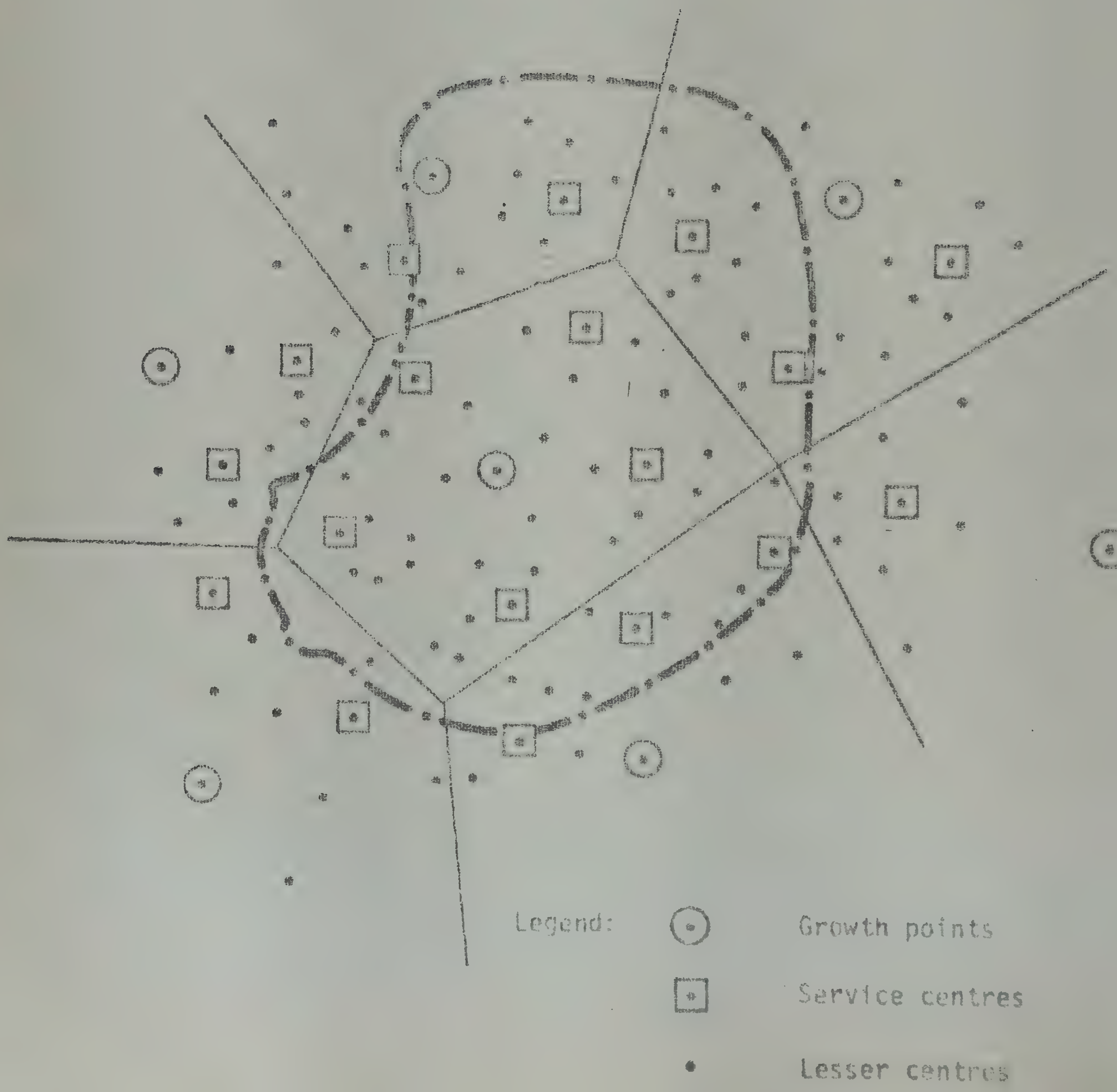
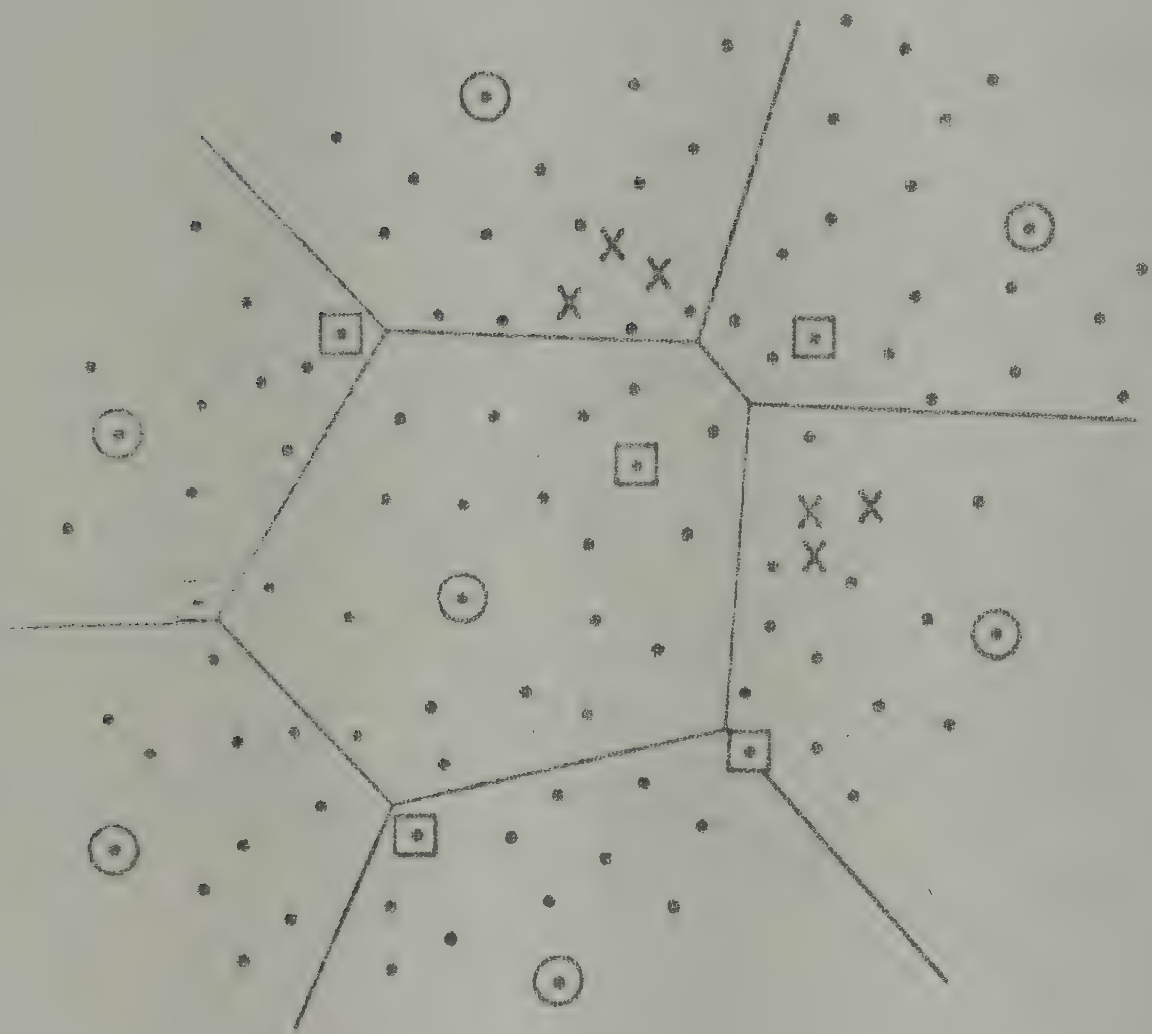


Fig. 12.13 SELECTION OF SERVICE CENTRES: EXAMPLE OF A MIXED PLANNING MODEL

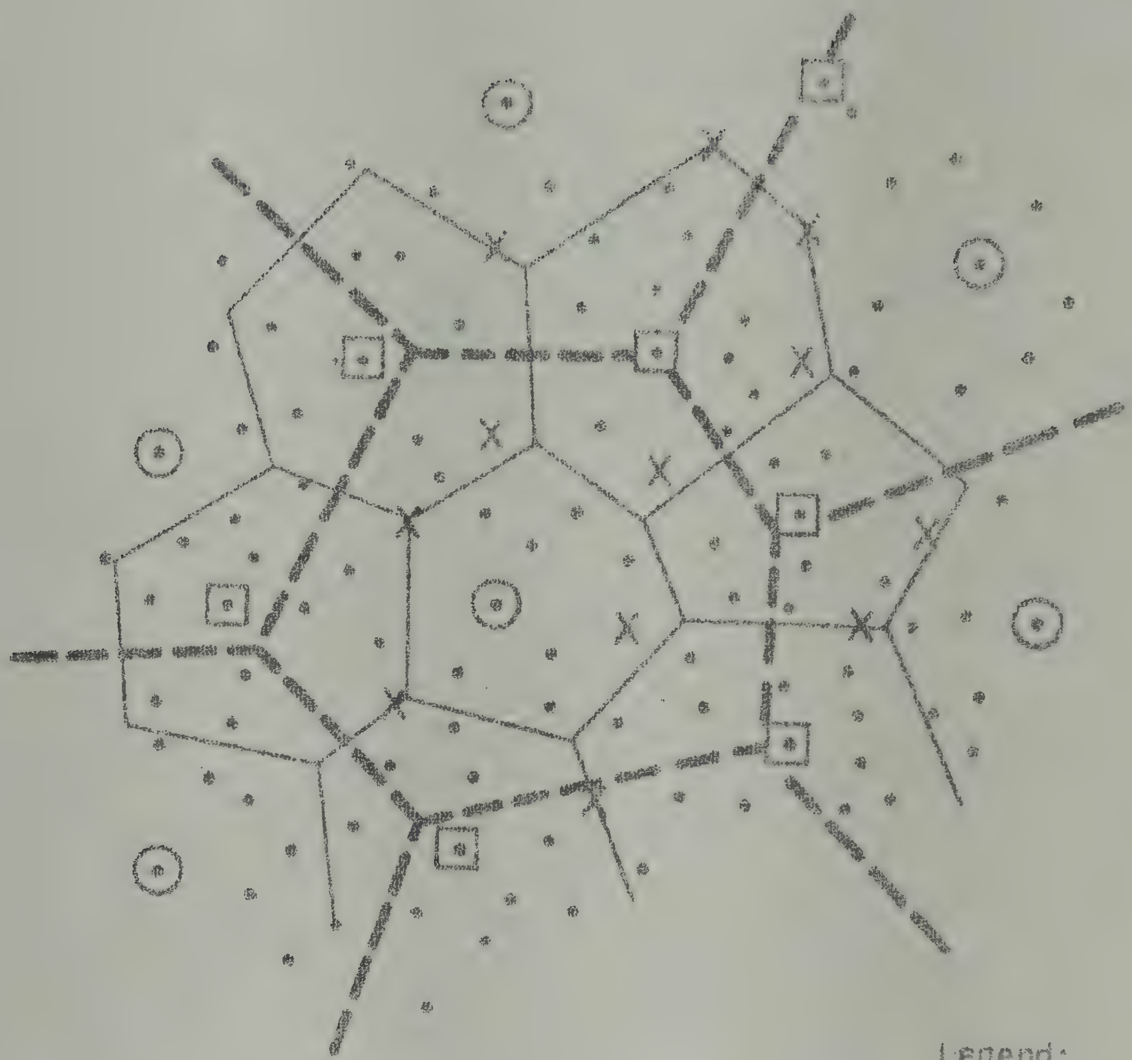



In the upper-right corner, two service centres serve the villages in the area between the growth points. Note that despite the addition of an extra service centre as compared with the situations in the pure planning Model B situation, some villages (marked with x) are now further from the nearest place with a service centre, or from a place of greater importance. This illustrates the inefficiencies that arise when planning models are mixed in the same system. Mixing planning models should, therefore, be avoided whenever possible.

Fig. 12.14 PROGRESSIVE SUBDIVISION OF THE GENERAL SETTLEMENT PLAN

PLAN A

Planning Model B
used for both levels



Legend:

Growth Points

Service Centres

Central Villages

Other Villages

The area is the hypothetical area used for the planning Model.
Local centres in the right-hand side of the diagram have only
been identified. Note that planning model B is used to identify
centres at both levels in the plan (a) but that planning model A
has been used to identify the lowest level set of centres in the
plan.

Fig. 12.15 PROGRESSIVE SUBDIVISION OF THE GENERAL SETTLEMENT PLAN

PLAN B

Model B used for service level and
Model A used for central villages

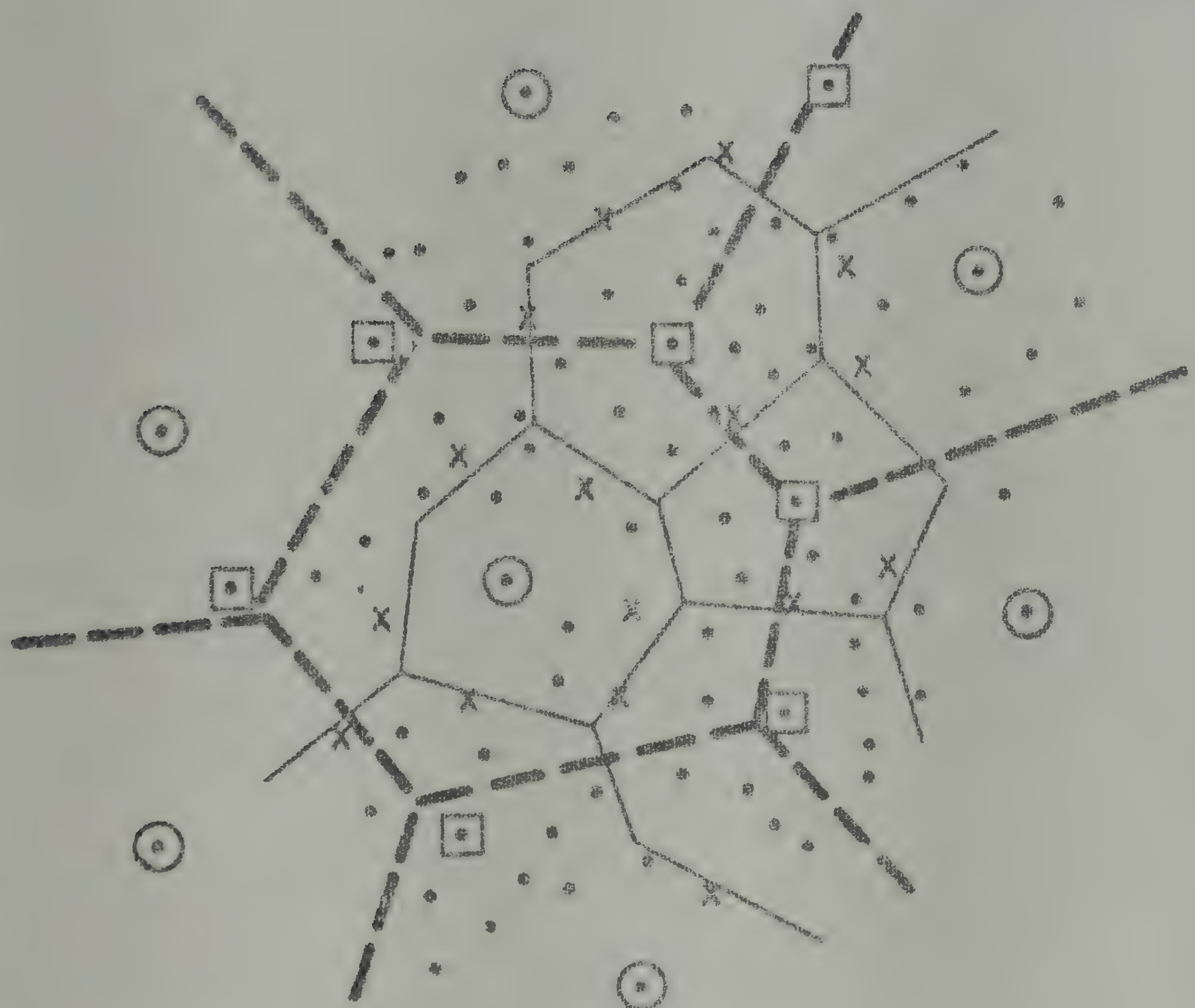


Fig. 12.16 PARTIAL SUBDIVISION OF THE SPACE BETWEEN THE SERVICE CENTRES


New centres are denoted by X's. These centres are the first centres to appear in a new set of centres that ultimately will develop to serve the area as development progresses.

Locating facilities in the plan context: Suggestions for appropriate locations for new services or facilities should be made after working down the settlement hierarchy starting with the topmost level place. In some parts of the study area it may be feasible to progress to lower level service centres with a particular service than in other areas where local conditions around the same level of centre as in other parts of the study area may not be suitable for locating the service at a particular point in time. Villages in such an area would obtain the service from the higher level centre. The rule that should be followed is that within any local area a service or facility should not be introduced at any centre until the higher level centre to which it is subsidiary has the service. When that has occurred, the service may be introduced to the lower level set of centres where the appropriate standards are met. Selection from among centres at a given local level is usually made on the basis of quite detailed information and circumstances not normally available at the time of formulation of the general service centre plan. The plan, however, provides a reduced set of locational choices to the decision-makers.

Chapter XIII

# PROJECTS OF INTEGRATED RURAL DEVELOPMENT*

## A. Introduction

### 1. Agricultural or rural development

One distinction that is crucial in comparing different projects or programmes is related to their basic objective. Is that objective to increase agricultural production or is it to increase the satisfactions, economic and noneconomic, of rural living?[1] Each of these aims is legitimate.

Programmes designed to serve one of these objectives almost always contain elements relevant to the other. Obviously, increasing agricultural productivity is an important part of increasing the satisfactions of rural living, since without it most rural family incomes cannot rise. But the extent to which greater agricultural productivity will in fact increase the satisfactions of rural living depends on how the rewards of the increased production are divided among landowners, tenants, farm labourers and urban consumers. Moreover, not all rural dwellers are farmers or

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* Edited version of a paper presented by T.A. Mosher, formerly President of the Agricultural Development Council, New York, at the Symposium on Agricultural Institutions for Integrated Rural Development Administration, Rome, June 21-28, 1971.

1. The term rural is used in this paper to cover both the open countryside and villages or towns that do not include much production of nonagricultural products for sale predominantly in large cities, and very few of whose inhabitants, if any, commute to jobs in larger cities.

farm labourers; some are employed in various service activities or are currently underemployed or unemployed. For them family incomes must arise from some other source than farming. And some aspects of satisfaction in rural living are largely independent of family incomes. These depend more on the availability of public services - education, agencies of law and order, public health and family planning services - and on opportunities for social participation whether in recreation, government, or the management of group activities.

It is to be expected, therefore, that different projects will include different combinations of activities, depending on whether the major objective is agricultural or rural development.

2. <u>Systems or subsystems</u>?

It is fashionable these days to think in terms of "systems" of activities. We recognize that agricultural development involves a large number of disparate activities that must be orchestrated in one way or another if agricultural production is to rise. Similarly, rural development involves the interaction of a large number of different activities that constitute another system. Some elements are common to both systems (such as provision of adequate agri-support activities) while others are an integral part of one system but not of the other.

Most actual projects of the types discussed in the symposium, however, can more accurately be described as constituting subsystems. That is, each is composed of fewer elements than the total number that comprise the system of which it is a part. The chosen elements are the ones thought to be especially crucial, or they comprise a group of elements among which the complementarities are thought

to be particularly strong, or they are the ones on which it is possible for a particular administering agency to work. Thus, many agricultural projects do not include adaptive research or price subsidies because these are beyond the resources or authority of persons within the limited territory covered by the project.

3. Simultaneous or integrated activities

Another important distinction is between the need for a certain group of activities to be administratively integrated, and the need for them to be simultaneously available but not necessarily integrated. For example, rapid adoption of a new higher-yielding crop variety requires that the necessary inputs be locally available. It is expedited by the availability of production credit and it may be accelerated by the activities of a competent extension service. The major requirement is that such services be simultaneously available and it is frequently possible for that to be achieved without administrative integration. Farm inputs can be made available by private merchants, by co-operatives, by farmers' associations or by government agencies. Credit can be supplied by any one of these types of agencies. Extension normally is a public activity, although salesmen for farm inputs can also provide aspects of it. Different combinations of administrative arrangements can provide simultaneity; administrative integration is only one way of achieving it.

## B. A System of Classification

The following table presents a schematic form of classifying most of the actual types of integrated agricultural or rural development projects now being carried on.

| Overall Agricultural Development | Project Activities | Types of Integrated Projects |
|---|---|---|
| A | B | C |
| I Research | 1. Markets for Farm Products<br>2. Retail outlets for Farm inputs<br>3. Production Credit<br>4. Extension Education<br>5. Local Verification Trials<br>6. Farm-to-Market roads | 1. Agricultural development projects (selections from among B 1-6) |
| II Producing or Importing Farm Inputs | | |
| III Rural Agri-Support Activities | | |
| IV Production Incentives | Nonagricultural<br>7. Rural Industries<br>8. Rural Public works<br>9. Community Development Construction Projects<br>10. Group Activities-Recreational, Cultural<br>11. Home Life Improvement Extension services<br>12 Health facilities<br>13. Family Planning Programmes<br>14. Schools<br>15. Local Govt.<br>16. Religious Activities | 2. Rural development projects with an agricultural component (selections from among B 1-13) |
| V Land Development | | |
| VI Training Agricultural Technicians | | 3. Rural development projects without an agricultural component (selections from among B 7-13) |

Table 13-1

Column A presents a list of the elements of the system of overall agricultural development. It groups the various activities that are involved into six categories:

I. Research to develop new technology that can allow agricultural production to rise.

II. The manufacture or importation of farm inputs that will allow the results of research to be utilised by farmers.

III. A set of rural agri-support activities that provide the rural "circulatory system" for goods, ideas and financing that makes it possible for farmers to participate in raising agricultural production.

IV. Provision of adequate production incentives - price and tenure relationships - that make it profitable for farmers to increase production.

V. Land development activities, such as irrigation and drainage.

VI. Provision for training scientists, technicians, and administrators to man all agricultural development activities.

Column B lists the kinds of activities included in one or another of most integrated agricultural or rural development projects and shows the relationship of these to the elements of the overall agricultural development system depicted in Column A. Items B 1-6 are the various activities that, taken together, comprise the rural agri-support activities (A III) listed in Column A. It will be noted that it is these activities (or selections from among them) that make up most integrated agricultural development projects.

Items B 7-16 represent activities that do not contribute directly to increasing agricultural production but

those that help to increase the satisfactions of rural living in other ways. However, integrated projects seldom include schools, local government or religious activities. Thus, integrated rural development projects normally include any combination of items B 1-13, depending on which ones are considered to be needed locally and feasible for the project to undertake.

## C. Types of Integrated Projects

Based on the considerations presented above, it is possible to identify six major types of integrated projects. Each type consists of a different combination of the elements listed in Columns A and B of the Table. All of them have two characteristics in common.

First, each such projects is limited to a specific land area; it is not a nationwide programme, at least in the beginning.

Second, each such project is (or should be) limited to elements not already present and reasonably effective in the project area. Local markets for farm products are essential, but if they already exist in a particular area they may not appear in an integrated project developed there. The same can be said about health facilities, production credit, or any other element. The emphasis in designing in integrated project for a particular area should be, and usually is, on providing the missing elements of a particular sub-system, not duplicating activities that are already proceeding with reasonable effectiveness.

Three of the types of integrated projects combine elements of Column B with one of the elements in Column A.

Type I consists of projects like that reported from Iran of which one element is a change in the land tenure system (A IV). Such a project usually needs to include all agri-support activities (B-1-6) that are not already present and functioning in the area. It may also include one or more non-agricultural rural development activities (B 7-13).

Type II consists of projects like the one in Egypt of which one element is the introduction of a new irrigation system (A V). The other elements are selected from within the same range as Type I.

Type III consists of projects like those of the Federal Land Development Authority in Malaysia of which one element is the opening of new agricultural lands to settlement (A V). The other elements of such projects, again, are selected as in Types I and II.

While in each of the above cases an element from Column A has been listed as one element in the integrated project, it should be emphasized that the important consideration is <u>simultaneity</u>. The actual administration of land reform, construction of irrigation facilities, or clearing new lands and getting them into cultivation involves intricate technologies and may, therefore, be most effective when separately organized. The important thing is that where land reform, or irrigation, or settlement is undertaken it is most likely to bear full fruit if an integrated agricultural development programme embodying appropriate activities from Column B is launched simultaneously in the same area.

The other three types of integrated projects do not include any elements from Column A (except selections from among those that are rural agri-support activities (A III)

and appear as items B 1-6). Instead, they are limited to selected elements from Column B, and the selection in each case is determined by the objective of the programme.

Type IV consists of projects that concentrate on agricultural development, such as the Intensive Agricultural Districts Programme in India. They normally consist of items B 1-4 only. Few of them include local verification trials (B 5), but all of them should. Few include attention to farm-to-market roads (B 6), although the adequacy of economical farm-to-market transport is essential to their full success.

Type V consists of projects having the objective of rural development, but giving substantial attention to agricultural development in recognition of the importance of raising farm family incomes. Such projects contain elements selected from among items B 1-13. Various projects in which the Israeli technical assistance agency cooperates appear to be of this type.

Type VI consists of projects that concentrate on non-agricultural rural development and therefore include elements from among items B 7-13 only. Their pertinence arises in two cases. One is where the agricultural programme elements are satisfactorily being cared for by other programmes. The other is in rural areas where agricultural growth is not a near-future possibility (given existing technology or foreseable advances in it), but where substantial numbers of people now live, many of whom may be engaged in largely subsistence agriculture.

Delineating these six types of projects seems to the writer to have two advantages. First, it facilitates the

comparison of different projects and helps to avoid making the false judgement that all integrated projects should contain the same elements. At the same time, since different conditions prevail in different parts of each country, this typology can be useful in deciding what kind of integrated project should be introduced in a particular place.

### D. Adjusting Types of Projects to Local Needs

#### 1. Selecting an area vs. selecting a type of project:

Persons who launch integrated projects do not all approach it in the same manner. Some begin with an interest in a particular type of project and then set about trying to identify the most suitable place to locate it. Others start with concern about a particular area or type of area and then consider what type of programme would be most appropriate for it.

Since most countries have different areas requiring different types of projects or programmes, and both humanitarian and political considerations dictate an appropriate concern for all parts of each country, the second approach identifying types of areas and then trying to devise appropriate types of projects for each of them appears to be primary. At the same time, advantage should be taken of the interest and competence of certain domestic or foreign organizations in particular kinds of programmes since there are areas in almost every country where each type of project is appropriate.

In other words, those responsible for the agricultural and rural development of their country should get a good grasp of the variations in local potential that exist in different parts of the country and then select

appropriate types of projects for each of them. Meanwhile, they should be alert to the special interest of particular persons or organisations, domestic or foreign, in particular types of programmes, and try to expedite their activities in those parts of the country to which their special interests are pertinent.

2. <u>Delineating types of areas</u>:

A classification of parts of each country proposed by the writer in another context (Mosher 1969) to be useful in locating integrated projects of Types IV, V and VI.* That classification is based on the potential for agricultural growth of each part of the country and on the immediacy of that potential.

I. <u>Immediate (agricultural) growth potential</u>:

Most countries have lands on which it would be possible to increase agricultural production substantially within the next two to five years, given appropriate public programmes and stimulation of private activities. These are areas that have good soils, appropriate temperatures, adequate rainfall or installed irrigation, and for which pertinent new technology to support higher production is already available.

It is in such areas that integrated projects of Types IV and V can be highly productive, because what is actually impeding full exploitation of the potential in such areas is adequate agri-support activities: markets for farm products, local outlets for farm inputs, production credit, a competent

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*. The location of projects of Types I, II and III is determined by where projects of land reform, irrigation, or land settlement are being undertaken. See Mosher, A.T., Creating a Progressive Rural Structure, Agricultural Development Council, New York, 1969.

extension service, local verification trials, and farm-to-market roads.

II. Low (agricultural) growth potential:

At the other extreme, most countries have lands for which the foreseeable agricultural growth potential is very low, even though many people may now be engaged in farming. The outlook for such areas is bleak and integrated agricultural projects would show very meagre returns and would be uneconomic. However, the people living there do deserve appropriate help in increasing the satisfactions of rural living in those places as much as may be possible, plus greater mobility to move elsewhere as employment opportunities in other places become available.

Consequently, areas of low agricultural growth potential are appropriate places for non-agricultural integrated projects of Type VI.

III. Future (Agricultural) growth potential:

In between the two types of areas described above, most countries have substantial land areas that have a possible growth potential beginning five or more years from now, but not sooner. These are areas where soils and climate are good but where one or the other of two elements essential to an immediate growth potential is now lacking. It may be that irrigation is needed before the area can move forward, and it will take several years, and substantial financing, to provide it. Or it may be that new technology to make higher production of crops that can be grown in the area possible is not now available. To provide it will require adaptive research that, again, will require time as well as money and competent research workers and organization.

For the time being, then, an emphasis on integrated agricultural development projects would be uneconomic in areas of future agricultural growth potential. Instead, resources available for application in such areas should be concentrated on research and/or irrigation, as may be needed.* But integrated non-agricultural rural development projects (Type VI) can be helpful in such regions, partly to get on with the non-agricultural phases of rural development and partly because every step in the direction of making rural communities more dynamic and participatory will help to accelerate agricultural growth once the technological base for it has been laid.

When the research or irrigation or transportation access that is the immediate need has been completed, then the content of projects in such areas can be expanded to include appropriate elements related to agricultural development.

3. Scope for multiplication:

The term "pilot project" is frequently applied to integrated projects, reflecting the hope that one project, began on a modest scale, will encourage multiplication of it at a later date over a much broader part of the country. It is argued that such pilot projects can serve three functions: they can prove the effectiveness of a certain kind of programme, they can furnish experience in learning about its problems, and they can serve as training grounds for personnel to duplicate that programme elsewhere.

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* A third lack that can hold an area back from having an immediate growth potential is lack of transportation access to the wider national (and international) economy. In such cases, the immediate priority should be given to providing such access.

This argument is sound, but care must be taken not to assume a wider applicability of a particular type of integrated project than is justified. A pilot project in one area of immediate growth potential might prove its applicability in other areas of immediate growth potential, provided the same new technology is profitable there, but it would be much less effective, and hence uneconomic, if reproduced in an area of future or low agricultural growth potential. Similarly, a Type VI pilot project that shows satisfactory results in an area of low agricultural growth potential might be appropriate for other similar areas but would miss the opportunity for rapid growth if reproduced in areas of immediate agricultural growth potential without incorporating agri-support activities in it.

Thus, the scope for multiplication of pilot projects is not unlimited. It can be substantial, but it is limited to other areas of the same type in each country.

## E. Common Problems

### 1. Size of individual projects:

We begin with the fact that the virtue of any integrated project is that it makes a set of complementary services conveniently available to rural families and that it facilitates intimate interaction in matters related to the satisfactions of rural living. These considerations define the importance of the farming locality, which is the land area that can be conveniently served by one "service centre": one place (usually a small market town) at which there are an established market for farm products, local outlets for farm inputs and production credit, and the services of an extension agent. Where people walk or travel

by cart such a locality center can conveniently serve rural people within a radius of three to five miles from the center.

Some integrated projects have been established for a single farming locality (as here defined) or even for a single village that may serve an even smaller area. But experience of the past twenty years has demonstrated that such projects are either not viable technically or are inordinately expensive. One reason is that two factors conflict in establishing the optimum size for a farming locality. On the one hand, convenience to farmers dictates having each locality as small as possible; on the other, economy in providing each service is increased by having each locality as big as possible. For example, farmers like to have fertilizers and credit available as close as possible but dealer's costs of operation (whether private, co-operative, or public) decrease rapidly with the number of farmers served by each local outlet.

The other reason why integrated projects servicing only a single village or a single farming locality are too small is that locality facilities must themselves be serviced by wholesale facilities, supervision, and (in the case of production credit) by rediscounting banking facilities. The farming district is the smallest land area that can provide the farming localities within it with these wholesaling, supervisory and rediscounting facilities and is, therefore, the "natural" optimum size for an integrated agricultural development project.*

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* It will be noted that this discussion of factors affecting the optimum size for integrated projects is in terms of agricultural projects. Similar considerations can be drafted for non-agricultural projects of Type VI and those may indicate that projects of that type can be somewhat smaller and still be effective at not too great a cost.

The actual optimum size for a farming district will vary widely from place to place. Normally it will need to be large enough to include at least ten farming localities and to include at least twenty to twenty-five extension workers (since that is the minimum number for effective and continuous inservice training). The upper limit is set by convenience in supervision and servicing from the district headquarters. In general terms, this means that the optimum size will normally lie somewhere between 1,000 and 3,000 square miles.* At that size, an integrated project can take advantage of most of the economies of scale of large projects, and is of a size that is appropriate for multiplication in additional units of similar size in other areas of the type to which it is suited.

2. <u>Location of individual projects</u>:

The major criterion for the location of integrated projects was discussed earlier. If agricultural development is a main objective, projects must be located in the areas of immediate growth potential where profitable new technology for crops or livestock products for which an adequate market for substantially increased production is readily available.

An additional criterion should be added in the case of pilot projects that it is hoped will be extended later

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* The various criteria to be taken into account in deciding on the size of farming districts, and hence of integrated projects, are described more fully in creating a Progressive Rural Structure, <u>op</u>.<u>cit</u>., especially pp. 110-13, and pp. 148-55.

to other areas. It is that the pilot project be located somewhere within, and preferably near the middle of, a much larger area or roughly comparable potential. It should not be located either in an area of unique characteristics or in one that, although typical of a larger suitable area, is isolated from it.

3. Meeting the needs of small farmers:

Discussions of how best to meet the needs of small farmers are frequently confused by failure to distinguish between three different situations.

One case is where "small" means small in absolute terms: farmers having so little land that they can scarcely be expected to gain a reasonable family income from farming. In such cases, the only solutions (short of combining several small farms and finding full-time non-farm employment for those farmers who are displaced) are either to develop new technology appropriate for intensive types of farm production that require very little land (including vegetable, poultry and some types of livestock production) or to develop part-time off-farm employment opportunities. Both of these approaches need to be pursued wherever the number of small farmers, in this sense, is larger.

The second case is where "small" means small in comparison with the land holdings of other farmers in the same region. Here, again, one solution lies in developing profitable types of labour-intensive production. Another consists of making arrangements that give small farmers as effective access to farm inputs, credit, and extension services as big farmers have. The simplest way to achieve the latter, as well as that which is economically most defensible, is (instead of setting up special programmes

for small farmers) to design the operation of all activities within all integrated projects primarily to serve the small farmers within the project area. If that is done, larger farmers will still share in utilizing them. It is when services are designed without the small farmers primarily in mind that large farmers tend to monopolize them.

The third case is where the term "small farmers" is used as a synonym for "subsistence" farmers - those who do not produce for the market. Here the fact must be faced that full-time subsistence farmers rarely if ever do, or can be induced to, increase production while remaining subsistence farmers. Increasing production almost always requires the use of new inputs - purchased inputs. Inputs will be purchased only for use on products that are sold, bringing in cash. The one exception to this, and it is important, is that where some part-time off-farm employment is available, subsistence farmers frequently do buy purchased inputs to increase the production of crops grown for home consumption. So the two remedies for the plight of subsistence farmers are (1) to shift to production for the market, and/or (2) to get some part-time off-farm employment both for what it will add to family income and to finance the purchase of inputs to increase farm production for home consumption.

4. <u>The role of the private sector</u>:

Integrated projects are almost always public projects; they are seldom private-for-profit organizations. Some of their elements must be public, particularly education, both formal and "extension". Community health facilities are firmly established as a public responsibility in most developing countries. The provision of roads and postal services is a public function. But many agri-support

activities that are so important in most rural development programmes can be either governmental, co-operative or private-for-profit. Should they all be undertaken as public activities and thus made an integral part of "integrated projects"?

No issue led to more widespread disagreement in the symposium than this one. From the discussion one would conclude that most participants fell into one of two camps. One group felt strongly that the only "right" way to organize agri-support services for which farmers pay as they are used is through member-controlled and government-free co-operative societies. The other group did not so much contest that view as argue that in the initial stages it is better for commercial agri-support services to be provided by governmental agencies, until such time as rural people may have learned how to operate co-operative societies effectively. Only a few participants suggested that private operation of these activities is not always bad, and that many privately operated agri-support activities are not as rapacious as they are widely believed to be. The writer was among this small minority group.

From the individual farmer's standpoint, two considerations are primary. First, are the needed agri-support services readily available nearby (by whomever operated); second, does he have a choice among two or more merchants or lenders (whether private, co-operative, or governmental), or is he practically forced to deal with a particular one because no other is easily available to him? Farmers tend to distrust all middlemen, whether private, co-operative, or governmental, and particularly if they have no choice among them. Yet it must be recognized that there is a natural tendency toward monopoly

wherever the size of functioning farming localities is small due to rudimentary transportation and communication facilities. Where such monopoly exists, it would be uneconomic to overcome it. Public regulation is the only partial solution.

The writer would argue that the growth of co-operative societies should be promoted but that to give them a monopoly position with respect to any given agri-support services has many of the same ill-effects that arise when any other type of enterprise is allowed to monopolize the distribution of farm inputs, the marketing of farm products, or extending production credit. There are cases where governmental agencies to provide these services should be encouraged, pending the demonstrated ability of co-operative societies to handle them effectively. Private co-operation of such services should certainly be allowed and encouraged by appropriate extension education programmes to help merchants and lenders develop methods of operation in line with the needs of a modernizing agriculture. To the extent that agri-support activities can be privately managed it simplifies the public administrative burden; private savings may be drawn into productive investments in merchandizing and credit facilities, and there is considerable evidence that in many places in the developing world the farmer is at least as efficiently serviced by private agri-support activities as by public or co-operative agencies.

5. <u>Relating integrated projects to the general governmental structure</u>:

Some integrated projects are undertaken in the first instance by one or another ministry or other established agency of a government. Even there, a problem arises from

the fact that the different elements of such a project lie in fields that are normally the province of different governmental agencies, so jealousies or conflicts of jurisdiction are likely to arise. In addition, the administrative integration of different elements of a project must be accomplished at the level of the land area covered by the project itself and this is in conflict with each element of the project having a line relationship to regional and national units of the same type of activity. The majority opinion in the symposium was that the land area covered by the project should coincide with that of an established administrative unit of government* so that both project integration and a connection with general administration can be made at that point.

Even when the project area and that of an administrative unit of government are identical, the problem of local integration and nation co-ordination remains. Several countries have established separate regional and national administrative units particularly for integrated projects. In most cases this has been abandoned after a few years because of the substantial overlapping of interests and responsibilities with governmental agencies that have a single subject-matter focus. Moreover, since different parts of each country are appropriate for

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* There may be a conflict between this criterion and the writer's judgment, previously expressed, that the land area to be covered by one project should be that of a functional "farming district". Both criteria are important and need to be honoured in so far as they can be reconciled. It would be justifiable to reduce the land area dictated by the "farming district" concept slightly in order to achieve boundaries coinciding with those of an existing administrative unit, but very much reduction would lead to reduce cost efficiency.

different types of integrated projects, having one set of regional and national units of administration for all integrated projects would be ambiguous, and having a separate set for each type of project would result in a proliferation of agencies.

6. Integrated projects and national planning:

Integrated projects must be financed. Sooner or later, they must get increasing financial support domestically. To accomplish that, their support must be integrated into national procedures of budgeting and planning. At this point they are at a serious disadvantage because they fit neither into established ministry budgets nor into a particular "sector" of the economy.

The best approach to this problem is to try to get the planning process changed - at least in so far as agricultural and rural planning are concerned - so that planning is disaggregated by regions rather than on the basis of specific kinds of activity,* or sectors of the economy. Different parts of the country need different kinds of agricultural and rural development programmes. It is not only integrated projects of which this is true. Different regions require different kinds of research, different kinds and quantities of farm inputs, different types and amounts of land development, etc. The amount of resources that should be allocated to these various activities should rest on a summation of the varying needs of different rural regions.

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* This topic is discussed much more fully in the writer's To Create a Modern Agriculture (New York: Agricultural Development Council, 1971), especially pp. 123-26.

If such a change could be made in procedures for planning and budgeting, integrated projects would no longer be a unique and special pleader for financial support. Instead, they could appear in specific regional proposals along with other major elements of development, and find their way from there into national plans and budgets.

7. <u>"Popular participation" in integrated projects</u>:

Are integrated projects for rural people **designed by someone else or** by rural people for their own development? Ideally, we might prefer that they should be the latter. In practice, integrated projects almost never arise primarily in that way. Almost universally they are designed and launched by some outside group. The group usually is a national or regional government, or an external technical assistance agency, either governmental or private. In some cases it is a domestic non-governmental agency.

In practice, then, almost all integrated projects are initially designed for rural people. Those that endure and thrive, however, are almost invariably those which have the benefit of considerable participation by rural people in modifying the programmes over time and even in administering it.

The need for popular participation should be recognised from the beginning. Those who it is hoped will be beneficiaries should be made fully and continuously aware of what is planned. For some parts of a project popular approval is necessary from the beginning; for other parts approval cannot be expected until after some concrete results are achieved. Participation in popular planning and administration is likely to come slowly, but it is unlikely to come at all unless it is vigorously promoted from the beginning.

There is no clear-cut solution to the problem. The least undesirable semi-solution would appear to be to have the regular field staff of all government agencies for types of activity included in each integrated project administratively responsible to the unit of governmental administration most nearly coinciding with the land area of the project, and then have a small advisory staff at the regional level for each specific type of integrated project. The purpose of this regional (or national) advisory staff would not be to exercise administrative control but to counsel with the staffs of each integrated project about ways in which the project might be improved.

A special form of administrative problem is met whenever a pilot integrated project is launched completely independent from any connection with the regular administrative structure of the government. Such a form may be adopted on the grounds that complete independence is needed for innovative freedom and that, if the project is successful, it can later be "adopted" by the government and the problem of administrative relationships faced then. Experience has shown that this seldom works. Governmental officers typically look upon any independent project as an implicit criticism of their own established activities and are therefore, more eager to see it fail than succeed. They are less likely to want to learn from it than to discredit it. Consequently, it is worth taking considerable plans to have the initial pilot project not only approved by, but administratively related to, an established unit of governmental administration from the beginning.

Chapter XIV

## PROJECT FORMULATION AND EVALUATION-I IMPORTANT ASPECTS*

From this chapter onwards we propose to deal with the problems of identification, selection, preparation and evaluation of specific rural area development projects. According to the World Bank, a project should be investigated from six different aspects:

1. Economic
2. Technical
3. Managerial
4. Organizational
5. Commercial, and
6. Financial.

The relative importance of these different aspects varies considerably according to the type of project involved; and they may overlap, with the result that a particular topic may be considered from several points of view. The task obviously requires experts with a variety of talents working together - particularly, engineers, economists, financial analysts, together with specialists such as resource analysts, agronomists, architects, educators and others.

### The economic aspects:

The appraisal of a proposed project from an economic point of view represents an attempt to answer three questions: is the project in a sector of the economy whose development is likely to contribute significantly to the development of the whole economy (i.e., is it in a sector which deserves priority); is the project likely to contribute effectively to the development of that sector; and

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* Reproduced from J.A. King, Jr., Economic Development Projects and Their Appraisal, Batlimore: Johns Hopkins Press, 1967, pp. 5-15.

is that contribution likely to be great enough to justify the use of the quantity of scarce resources that will be needed - investment capital, domestic and foreign; managerial talent; skilled labour; and the like.

To answer the first question requires a study of the entire economy. Such a study may have been made by the government itself in the preparation of an economic development programme and in that case, both the study and the programme that rests upon it must be evaluated. These analyses can provide reasonable estimates of the general level of future requirements for goods and services and thus furnish indications of the relative priorities of various projects.

An important element in answering the second and third questions is an analysis of the demand for the goods or services to be provided by the project. Although some indications of demand may be given in a development programme, more precise and detailed estimates are likely to be required. The character of the analyses of demand (or market studies) needed will vary from sector to sector and even from project to project. For example, determining the demand for a small power project would necessitate a study of only a modest market area, but the assessment of a new iron ore mine might well require a study of the world market.

A first indication of the economic justification of a project can be obtained by calculating an economic rate of return for it. Such a calculation compares the measurable costs and benefits of the project to the economy as a whole, assigning to each a value which approximately

reflects its real scarcity. In an economy in which market forces operate freely in the presence of domestic and international competition, the actual prices of all factors of production could be used in making such a calculation. But in the real world, there are major interferences with the free play of demand and supply: for example, protective tariffs and quantitative restrictions on imports and exports; unrealistic rates of exchange; government controls of interest rates, prices, production, and sales; private monopolistic controls of production and prices; and wage rates exceeding the real cost of labour because of government or trade union action. These distorting factors often make an appraisal, based on actual prices, of the economic merits of a project incomplete and inaccurate. Sometimes enough information is available on the real, undistorted costs to the economy of the main resources required so that appropriate adjustment can be made of the values of costs and benefits arrived at by the use of actual prices. In many cases, however, only a qualitative adjustment is possible.

Among the costs and benefits to be considered are the effects of the project on the balance of payments. These effects can be both positive and negative; a project may earn or save foreign exchange by generating new exports or replacing goods formerly imported, or may give rise to new claims on foreign exchange by creating a continuing need to import raw materials, fuel, or spare parts and by creating additional foreign debt.

To determine whether the proposed project represents the least-cost method of achieving the objectives it will serve, the costs and benefits of the best alternatives must also be estimated. In transportation projects, this might mean comparing the net benefits of railways and highways

in the particular situation; in power, it might involve comparing the net benefits of a series of small thermal plants to be constructed over a number of years with those of a large hydroelectric plant to be constructed at one time.

In some countries, population is growing faster than opportunities for productive work, and labour may be plentiful. Taking account of the real cost of labour in such a case, a project which provides many jobs would possess an economic advantage over a project with roughly the same net benefits but which is capital-intensive and provides relatively little additional employment. Even in such a situation, however, there would be no justification for designing a project to "make work" in an industry which by its nature is capital-intensive.

In making comparisons between different projects, it is often necessary to allow for differences in the time-pattern of their costs and benefits. Projects usually involve a stream of annual expenditures - initially for construction, later for operation and maintenance - and a stream of annual benefits, usually coming later than the expenditures and often building up more slowly. Some projects may start producing benefits relatively quickly. In other cases, construction may take a number of years, and some time may pass before significant benefits begin.

A benefit of a given amount is obviously more valuable this year than, for example, in ten years' time. If it accrues this year, it is assumed that the benefit can be reinvested in the economy to secure additional returns in coming years. Yet it does not automatically follow that projects which produce benefits most quickly

are necessarily the best. If the eventual benefits from a project with a long gestation are big enough and are not too long in coming, and if the cost of waiting for them is not too great, this project may be more attractive than others which pay off quickly but more modestly. Therefore, differences in the relative timing as well as the size of costs and benefits need to be taken into account when appraising projects.

The timing problem is taken care of by the use of discounting, which reduces future costs and benefits to their present worth. Under one such technique, which the Bank has used extensively, the streams of costs and benefits attributable to a project in each year of its useful life are discounted to a point in time (usually the start of construction) at a rate which will make the totals of the two streams equal. The discount rate which will produce this result is the project's internal rate of return, i.e., its earning power. A comparison of a project's internal rate of return with the return on alternative investments of comparable risk is a key measure of its attractiveness. In making the comparison, however, it should be borne in mind that financial rates of return may be misleading, and that care must be taken in finding a valid comparison.

The calculation of the economic return may be significantly affected by the extent to which costs and benefits can be quantified. Indirect costs, those borne by the national economy though not by the project, may not be easy to identify (e.g., the amount of investment in infrastructure necessary to support a major project). But it is on the benefit side that the most difficult tasks lie. There are certain kinds of projects, such as school buildings or water supply and sewerage, which are clearly

indispensable to the orderly development of a country but whose economic benefits are extremely difficult to calculate. Frequently, so are the associated or indirect benefits of an industrial project, such as opportunities created by the project for related enterprises. For these reasons, the total costs and benefits of a project often cannot be determined quantitatively, and a sound economic view of projects must always depend to some extent on the judgment of those carrying out the appraisal. It is for this reason, in turn, that no amount of formal analysis can substitute for experience with actual projects in many places and under many different conditions, the kind of experience that enables an appraiser to "see" the unquantifiable benefits of a project clearly enough to have confidence in his judgment about its worth.

An economic analysis may sometimes lead to the conclusion that a project should be postponed a few years, or even that its objective could better be attained by other means. This may be a disconcerting result, but its importance need hardly be emphasised. Its implication is that resources could be used more effectively elsewhere.

<u>The technical aspects</u>:

In the technical appraisal of a project, the basic question is whether the project is sound from a technical and engineering point of view. Sound engineering is fundamental to project preparation and appraisal; it permeates every aspect. In spite of the great importance of engineering, the Bank does not undertake any original engineering work in the course of its appraisal. Instead, it makes a judgment of the capacity of those who have done the work and the reasonableness of the conclusions they have reached.

Methods of analysis vary from project to project and sector to sector, but there are certain recurring themes.

Perhaps, the most common requirement, imposed by the variety and complexity of factors to be considered, is the need for consultants to prepare or supervise the project. Though a factory or a public agency may have a competent engineering staff fully, capable of handling maintenance and operations, it may not be qualified to carry out all the engineering tasks required in the design and construction of a new facility. The tasks for which consultants may be needed vary greatly from project to project, but they may include some or all of the following: the design of the facility, the preparation of specifications and invitations to bid, the analysis of bids and the recommendation of the bidder to whom the contract should be awarded, the inspection of equipment purchased, arrangements for shipping and insuring imported equipment, the supervision of construction and installation, and even the initial control of operations of the completed facility. Consultants cost money, but their services frequently save many times their cost.

Questions often arise concerning the scale of the project. Certain facilities (for example, certain hydro-electric schemes) can work economically only on a large scale, and to establish such a facility on a more restricted scale may be a misuse of scarce capital. The minimum scale varies from one kind of project to another, but in the capital-intensive projects, the minimum economic scale is usually very large. The proposed scale of a project must, of course, be looked at not only from the viewpoint of technical efficiency and the costs of production, but also

from that of prospective demand. These questions are part of the problem of the timing of projects mentioned in connection with the economic aspects of project appraisal. Though it may be tempting to create a facility of a size which would permit production at very low unit costs when operating at capacity, it may prove more economical to adopt another alternative, if demand is unlikely to reach the capacity level until ten or fifteen years after the facility is completed. One alternative is to divide the project into stages in each of which unit production costs would be higher than the optimum attainable by the larger plant but lower than those likely to be reached by that plant for many years. Another alternative, if the facility is intended to produce finished goods that can be imported, is to continue importing until the domestic market becomes large enough to justify the construction of a plant economic in scale.

Consideration must also be given to the appropriateness of the proposed methods and processes. In fields where technological progress is rapid and new improved processes are being developed, technological obsolescence must be taken into account. In an underdeveloped country, however, simpler processes may be more appropriate. The more advanced processes, developed to reduce labour costs in a country where labour is relatively scarce and expensive, may not be appropriate where labour is abundant and cheap, or where the skills needed to operate and maintain these more advanced processes may not be available.

Questions of location and layout or design are technical factors that must be dealt with in projects of all kinds. Taking advantage of the best hydroelectric site may save large sums; finding a suitable route for a road may

reduce construction and maintenance costs. In industrial projects, account must be taken of the relation of the proposed location to the sources of raw materials, power, fuel and skilled and unskilled labour as well as to the market to be served. There may be advantages in locating near a large city if public utilities and housing are available there. On the other hand, the economics of the case may demand that the project be established near the source of raw materials, and in that event it may be necessary to include in the cost of the project the cost of building a town and the related public services. It may also be necessary to work out with the authorities responsible for basic services the timely provision of roads, railways or power lines to the facility.

The layout of a project may be very important, particularly in preparing for future expansion. In a power project, money may be saved in the long run by building, while the basic facility is being constructed, the foundations and related works for generators not to be installed until some time in the future. In the same way, forethought in laying out an industrial plant and locating it on the site can make future expansion easier and cheaper.

The scheduling of construction and the identification of potential causes of delay form an important part of the technical aspects of project appraisal. Timing of construction must be realistically planned. For all the main physical elements of the project, there must be realistic schedules which not only include all the actions - from engineering design through land acquisition, construction and procurement, to testing of equipment and training of staff - necessary to successful completion of the project, but which also arrange these actions in a coherent order leading to the completion of the project as a whole on the

most economical basis. These schedules must take into accoun seasonal or other variations in working conditions which might interfere with the project. Of course, scheduling is but the first step in the control and supervision of project construction.

Closely related to the analysis of schedules is the analysis of the estimated costs of constructing the facility. For such an analysis there should be a detailed budget in which the estimated cost is calculated for all the different phases of construction and for all the main physical elements of the project. This budget, of course, must be closely correlated with construction schedules, and for the purpose of control during the construction period, cost estimates should be broken down in the way in which contracts for construction and equipment are expected to be let, because only in this way can a timely comparison of actual costs with the estimates be made. The breakdown should reflect a separation of local currency and foreign exchange expenditures. Analysis of the estimates should start with an examination of the assumptions on which they were based, and every effort should be made to ensure that all costs associated with the project have been included. Because it is difficult to identify all these costs, the estimates should include adequate allowances for omissions, for physical contingencies, and for likely increases in general costs during the period of construction, Interest during construction should be included in the estimates. In reviewing cost estimates, the skeptical approach mentioned earlier is particularly desirable. Comparison of the estimated costs with the actual cost of similar projects is also often useful, and if there are major discrepancies, their cause should be determined.

Estimates of production costs as well as of costs of construction should be reviewed. Here, too, comparison with similar projects is useful. The estimates should be made for various operating levels, because facilities rarely operate at capacity from the moment they start up. Allowances must be made for starting expenses and the training of personnel.

The managerial aspects:

Management is perhaps the most difficult of all the elements of a project to appraise. Where a project is to be carried out by an existing organization, much can be learned about the quality of management from a study of what has happened in the past. Yet it often happens that a management with a good past record may be inadequate to handle a greatly expanded operation. In particular, managers may be reluctant to delegate authority; in a developing country this attitude may be quite reasonable, since there may be very few people qualified to handle the responsibilities delegated. But an organization that operates with a one-man management is very vulnerable.

The shortage of management experience and ability is one of the main difficulties standing in the way of economic development in many countries. It is in some cases compounded by an unwillingness to employ foreigners in positions of management responsibility or by the scarcity of suitable foreign personnel. One solution to thes problem may be a partnership between local investors and an existing foreign enterprise. Another possibility is to have professional managing agents provide centralized management services for a number of different organizations. Such solutions are not always practical, and there are many cases in which the only reasonable way to assure adequate

management is to import it. In some cases, management contracts can be arranged with a foreign organization; in others, individual foreigners can be employed. One of the objectives of such arrangements should be that the foreigners train local people to take their places as soon as is practicable.

Another difficulty frequently met with is the limited concept of the role of management: in a number of countries it is not understood that management is more than simply keeping a plant running, and other aspects - marketing, labour relations, financial planning and the like - are neglected. A special problem is posed by the management of government-owned enterprises, which are often handicapped by political pressures or by inflexibilities imposed by a bureaucratic approach to management problems. This approach frequently leads to inaction arising from a desire to avoid mistakes.

In general, the appraisal of management is an art and not a science, and the investigator has to rely on his personal judgment, based upon his own experience of men and affairs.

<u>The organizational aspects</u>:

Closely related to the question of management is the question of the sort of organizational structure best suited to carry out and operate the project successfully. This question falls naturally into two parts - what organization is needed to bring the project to the operating stage and what organization will be needed thereafter.

In the construction phase, the critical question usually is how much outside help will be needed. In some

industries, very commonly in electric power, the process of construction is almost continuous, with one project starting just as another is being finished. Thus a substantial power system will have its own design and construction department, familiar with its needs and problems, which will normally carry out the work related to construction, although it may call on consultants for help in very large projects or those with unusual engineering features. On the other hand, a smaller organization may have an engineering staff capable of handling only regular operations and maintenance. Such an organization obviously must obtain outside help when it is faced with a major expansion.

In the operating phase, one of the most common questions is the extent to which responsibility and authority should be centralized or delegated. The answer depends on the scale of operations, their geographical dispersion, the degree of specialization of personnel, and the number of persons to whom responsibility can be delegated. A project, whether it calls for the expansion of existing facilities or the creation of new ones, will almost inevitably change operating conditions. The existing organization must therefore be examined to see whether it will be suited to the new situation.

Internal controls must be reviewed since they are basic to sound organization. For management to function efficiently, the organization must be able to provide prompt reports on current performance that can be checked against both past performance and previous projections of future trends, so as to bring problems to light as they arise. It is equally important that the organization be able to put the decisions of management into effect without delay. In addition, sound budget and inventory controls

are needed. These in turn make possible the control and scheduling of production and preventive maintenance. Care in this respect is very important because in many developing countries the purposes served by these controls, particularly the function served by preventive maintenance, are not understood.

Finally, the analysis of the organization must include questions about the adequacy of the training programme to man the new facility. Since a project usually expands the size of operations and often requires new skills, its completion will not only put new strains on the existing internal controls, but will also require the employment of more persons trained in the familiar skill or of persons trained in new skills. Attention must therefore be given to the adequacy of training at all levels in the organization, from apprentices to candidates for management.

The commercial aspects:

The basic questions to be asked in appraising the project from the commercial point of view are whether adequate arrangements have been made for buying the materials and services needed to construct the facility, and, when construction is finished, for obtaining power, labour and raw materials to operate the plant and market its product. The problems are much the same for all projects during the construction phase. The main objective is to see that the proposed arrangements will ensure that the best value is obtained for the money spent. Effective competition among potential suppliers and contractors can be induced through international competitive bidding, and in the case of projects of any real size this is usually the most desirable arrangement. Of course, there may be

exceptions; for example, it may be more economical to standardize on the basis of existing equipment in order to reduce investment in spare parts and the cost of maintenance. Often the advice of consultants is essential in evaluating bids to take into account factors other than price, such as quality, the experience and reliability of the supplier, the terms of delivery and payment and so on. Savings on transportation and insurance may be possible in a large project by making centralized arrangements for these services.

In the operating phase, commercial problems vary considerably from sector to sector. In industry, for example, the likely terms of purchase of the ingredients of production and of the sale of products need careful examination, since these terms may have an important bearing on the amount of working capital required.

The financial aspects:

The following discussions of the appraisal of projects from a financial point of view is concerned primarily with projects that produce revenue. Of course, many projects do not fall into this category - for example, most highway projects and educational projects - and the financial appraisal of such projects differs somewhat from that of revenue-producing ones, being concerned primarily with the sources and adequacy of funds for the construction and maintenance of the project.

The fundamental purpose of financial analysis is to determine whether the enterprise to construct and operate the project is financially sound and, if it is not, whether and how it can be made so. All of the information gathered in the other aspects bears on the financial analysis. That

analysis usually examines two aspects of finance: the amount of money required to bring the facility into operation and the sources from which that money is to be obtained; and the probable operating costs and revenues, prospective liquidity, and financial rate of return in the operating phase.

In the case of a project to be carried out by an organization already in business, the first stage of the analysis consists of a review of past financial statements in which such questions are raised as: If the figure at which fixed assets are valued a realistic one? Are the receivables unreasonably overdue? Do the inventory figures include unsalable finished goods? What are the terms of existing debt? Is the depreciation policy sound? How much of the profits have been paid as dividends and how much retained and reinvested? Is working capital short? Have the earnings included windfall profits? Are inventories valued conservatively? Are there contingent liabilities or hidden reserves not appearing on the balance sheet?

Next the appraisers seek to determine how much money will be needed during the construction and breaking in of the new facility, by taking into account such of the following items as may be relevant: the cost of goods and services required, including engineering services; allowances for escalation and contingencies; the cost of other capital investments to be made during the period; interest during construction on new loans; service on existing debt; new working capital; and promotional, organizational, training, and other costs that may be associated with putting the project in operation, such as production lost due to poor product quality, break-in and adjustment of machinery and equipment, and the like.

For both existing and new enterprises, insufficient working capital frequently causes serious difficulties. Estimated requirements for working capital should be based on realistic assumptions concerning the amount of stocks of raw materials, spare parts, goods in process and finished products required; the terms on which products are to be sold, which will indicate the amount of receivables to be financed; and the amount of funds necessary to take care of fluctuations in payments and receipts, taking into account any seasonal variations in production or sales and the possibility of delays in delivery of imported items.

The third step in the analysis, for both existing and new enterprises, is to identify the sources from which the financial requirements for the construction period will be met. Normally, these sources will include funds generated from operations (depreciation and retained earnings); long-term and perhaps short-term borrowings; and government contributions in the form of equity or, in the case of private corporations, funds from the sale of new equity capital. To marshal the sources and to make sure they are adequate three kinds of financial projections should be prepared:

a) An estimate of earnings during the construction period of the enterprise undertaking the project, to determine the amount of internally generated funds which can be supplied to the project;

b) A cash flow estimate (an estimate of receipts and expenditures of the enterprise carrying out the project, from which it can be determined whether funds will be available when needed); and

c) Balance sheets which show the probable future as well as the present financial position of the organization.

These projections then have to be carried on into the operating period to show the likely financial results of the operation. In these forecasts, account must be taken of the time required to overcome initial operating difficulties and the rate at which the market may be able to absorb production. Corresponding calculations will have to be made of the growth in the amount of working capital required.

When these forecasts have been completed, it should be possible to form various judgments: whether there will be an adequate supply of funds during the construction period; whether the financial situation at the end of the period will meet the requirements of sound financial principles; whether the expected revenue during the operating period represents a reasonable return on the capital invested; whether there will be an adequate margin in the funds generated by operations to meet fixed financial obligations; and, in many cases, whether revenue will be adequate to establish reserves needed for sound operation and for further expansion.

In the light of these judgments, it should be possible to say whether the proposed financing plan is sound, or whether some change is necessary. They also permit the formulation of the conditions under which money should be made available by the Bank for the project. The object of these conditions will be, among other things, to ensure that subsequent action on the part of the management will not jeopardize the financial situation and prospects of the enterprise. These may include a limitation on its freedom to incur additional long-term debt, sometimes objectively expressed in a maximum ratio of debt to equity or of debt to fixed assets, or in a ratio of earnings to interest or to future debt service.

Chapter XV

# PROJECT FORMULATION AND EVALUATION-II CRITICAL PATH METHOD (CPM)*

## A. Introduction

During 1956-57, the Engineering Control Group of EI duPont De Nemours & Co of USA was seriously exploring the possibilities of using the modern computers in handling the complex problems encountered in managing various engineering projects. Their major aims were:

1. The development of a Master Schedule covering all projects.
2. The procedures to monitor, update and revise the Master Schedule in the most economical manner; and
3. The built-in provision by which all concerned persons are informed of the progress and consequential revisions, if any.

Their research efforts resulted in the development of the CPM approach.

The use of network techniques or models resulted in providing a systematic procedure for denoting the inter-relationships among various activities. This also resulted in distinctly separating the planning and scheduling functions.

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## B. CPM Approach

1. CPM stands for Critical Path Method. The name itself implies that the procedure identifies the most critical of all paths available through the network. Analysing the network we can identify those activities which should be expedited, and by how much in order to accelerate the project completion time. As indicated earlier, CPM is oriented towards cost. Cost was selected as the criterion, since labour, materials and equipment can easily be measured in terms of cost. Given the project schedule time, the most economical schedule is that which minimises total project cost.

2. The cost-time curve for a typical activity is shown in fig. 15.1.

For each activity, there are two cost-time combinations which are of interest to us. The first one takes into consideration the normal time needed to execute a task and the associated normal cost. The second one is the minimum time needed to do a job as a crash programme and the maximum cost required for this crash programme. This minimum time is known as the crash time and the associated maximum cost is known as the crash cost. Decreasing the time below the crash time is considered not possible. Increasing the time duration beyond the normal time will usually increase the cost because of inefficiencies associated with unnecessary extension of time (See fig. 15.1).

3. Since the normal and crash points are derived by estimating procedures which are only approximate, the time-cost curve can be represented by a straight line between the crash and normal points without any loss of significant

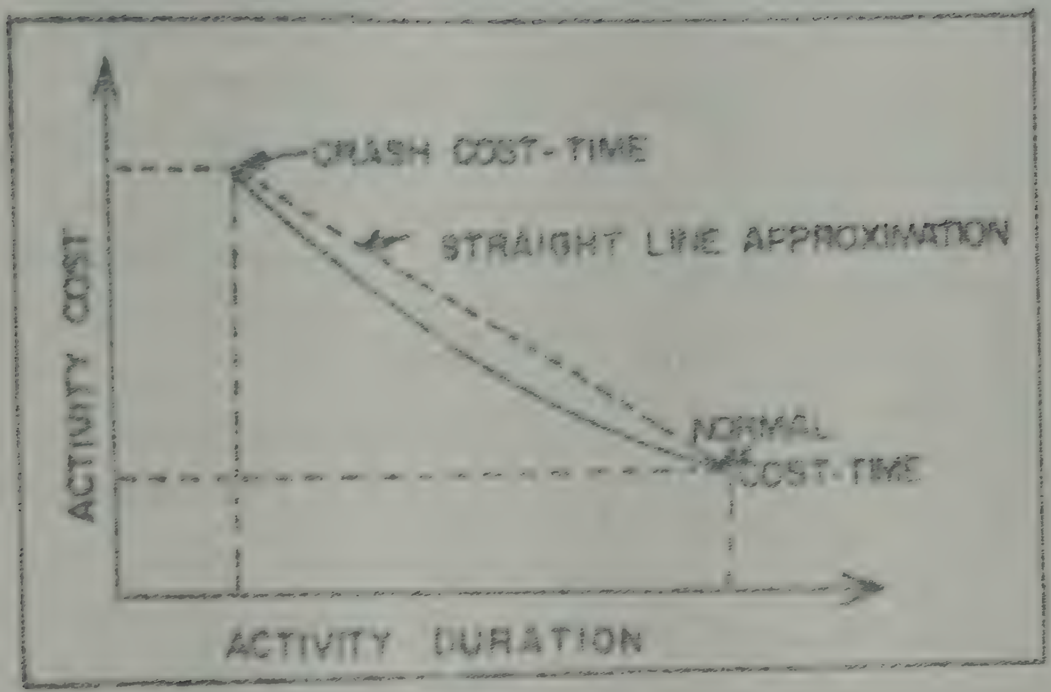



Fig.15.

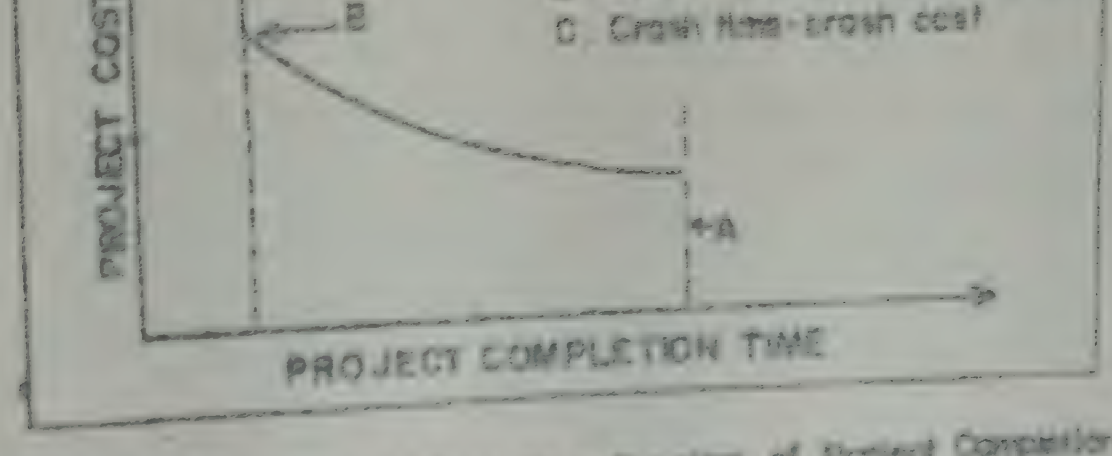



Fig.15.2: Total project Cost as a Function of Project Completion

accuracy. The slope of this line gives the rate at which the cost increases as the activity time is decreased. This slope can be used as the criterion for deciding which activities are to be expedited. Obviously, those activities with the smallest values of slope must be expedited first. This will result in the smallest increase in total project cost.

4. After the network has been prepared, normal and crash costs and durations are estimated for all activities. Dummy activities are assigned zero cost and zero time for both the crash and normal situations. By analysing the network using only the normal times and costs for each activity, the normal project completion time, the earliest and latest start and completion times for the activities, and the normal project cost can be determined. Using the crash times for each activity, a minimum or crash project completion time can be computed. The difference between the normal and crash completion times provides a range of possible project completion times. For each project completion time within this range, a minimum cost schedule can be computed. Each cost schedule gives a duration time for each activity, the earliest and latest start and completion times for each activity, and the total project cost.

5. Since the project completion time is equal to the sum of the time durations for the activities on the critical path compressing the critical will reduce the project completion time. The critical path is compressed by expediting the critical activities in accordance with the criterion previously stated,i.e., those activities with the smallest cost rates are expedited first so as to provide the smallest amount of increase in total project cost. The computational procedure expedites each activity to it's crash time before

expediting an activity with the next larger rate of cost increase. If two activities on the critical path have the same cost rate, the mathematical procedure is indifferent as to which activity is expedited. The activities are expedited only to duration times which are equal to, or greater than, the crash duration times, and which will cause the length of the critical path to equal the pre-assigned project completion time.

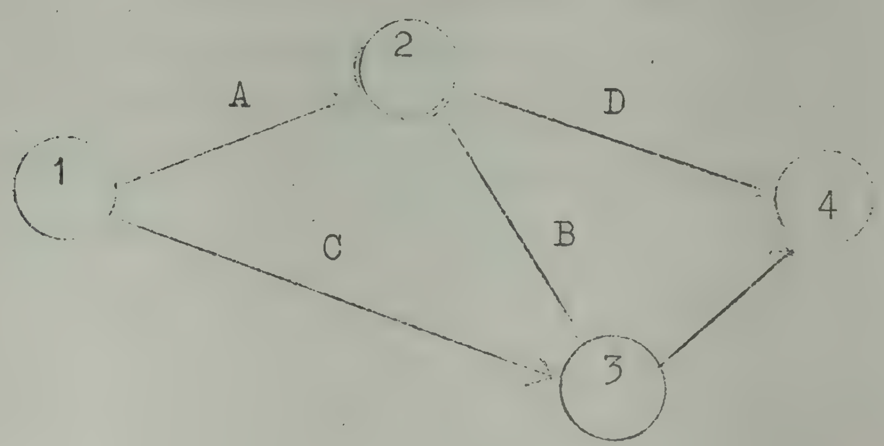
6. When the most critical path is compressed to a length equal to the length of the next most critical path, then both paths must be compressed to achieve any further reduction in project completion time. The process of selecting activities to expedite now becomes more complex. An activity on each path is selected according to the criterion previously stated. Since both paths must be shortened by the same amount of time, the two selected activities must be expedited by the same amount. The increase in total project cost will be equal to the sum of the cost slope for each activity multiplied by the amount of time by which the activities in common, the cost increase rates for those common activities are examined. Should the cost rate for common activities be the same, then expediting the common activity will decrease both critical paths by the same amount of time, and will increase the total project cost by an amount equal to the cost increase rate for that common activity multiplied by the expedited amount of time. As the project completion time is compressed, the number of critical paths (i.e., network paths whose lengths equal to project completion time) generally increases. This makes the computation of a minimum cost schedule complicated, because of the number of comparisons which must be made. For each selected project completion time, a minimum cost schedule

can be computed. Figure 15.2 gives a typical plot of minimum total project costs over the range of possible project completion times. In general, the minimum total project cost for the minimum or crash project duration is less than the total project cost based on expediting all activities as shown in Fig. 15.2(p.375).

7. The normal and crash costs described above were direct costs. For most projects, indirect costs are usually involved, as well as direct costs. These indirect costs normally include such things as overhead, general, administrative, and other distributive expenses. To arrive at a more representative picture of overall project costs, these indirect costs should be added to the direct costs. In some cases, indirect costs are directly related to the activities and can be estimated when the **range** of direct activity costs are estimated. More generally, however, indirect costs are related to the total project duration or to the project direct cost. Incentive fees and penalties, if applicable, should also be included in the total cost structure.

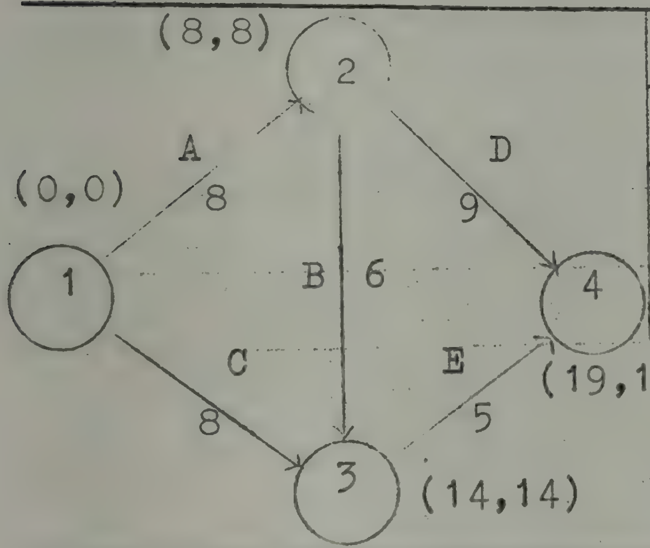
## C. Example

Consider the simple network shown below. It consists of five activities. The activity durations and direct cost for each activity are shown in tabular form The problems is to develop the alternative cost schedules for this project.



| Activity | Duration (week) | | Cost (Rs) | | Slope (Rs/week) |
|---|---|---|---|---|---|
| | normal | crash | normal | crash | |
| A | 8 | 2 | 3000 | 6600 | 600 |
| B | 6 | 3 | 2000 | 3200 | 400 |
| C | 8 | 6 | 2500 | 4500 | 1000 |
| D | 9 | 9 | 5000 | 5000 | - |
| E | 5 | 2 | 1200 | 3900 | 900 |
| Indirect costs: Rs. 500 per project week | | | | | |

Schedule 1: All activities at normal time

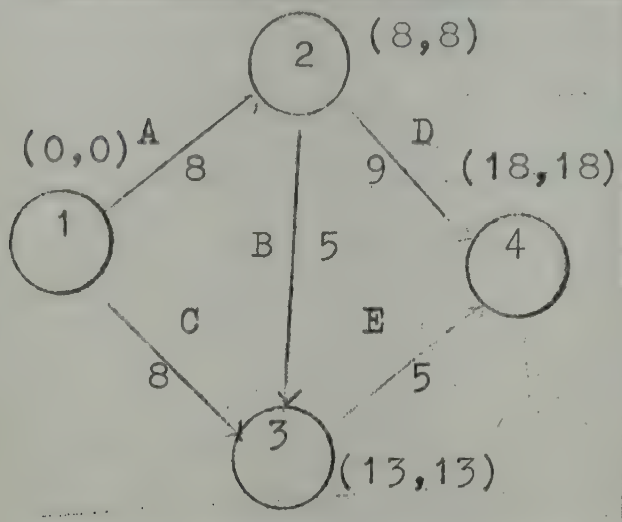



| Present | | | Plan | |
|---|---|---|---|---|
| Act | Weeks | Rs. | Crash | Slope |
| A | 8 | 3,000 | 2 | 600 |
| B | 6 | 2,000 | 3 | 400 |
| C | 8 | 2,500 | 6 | 1000 |
| D | 9 | 3,000 | 9 | - |
| E | 5 | 1,200 | 2 | 900 |
| Total | | 13,700 | | |

Project time: 19
Project cost: 13,700

Decision:
Shorten B by 1 week

Schedule 2: Short B by 1 week from schedule 1




| Present | | | Plan | |
|---|---|---|---|---|
| Act | Weeks | Rs. | Crash | slope |
| A | 8 | 3,000 | 2 | 600 |
| B | 5 | 2,400 | 3 | 400 |
| C | 8 | 2,500 | 6 | 1000 |
| D | 9 | 5,000 | 9 | - |
| E | 5 | 1,200 | 2 | 900 |
| Total | | 14,100 | | |

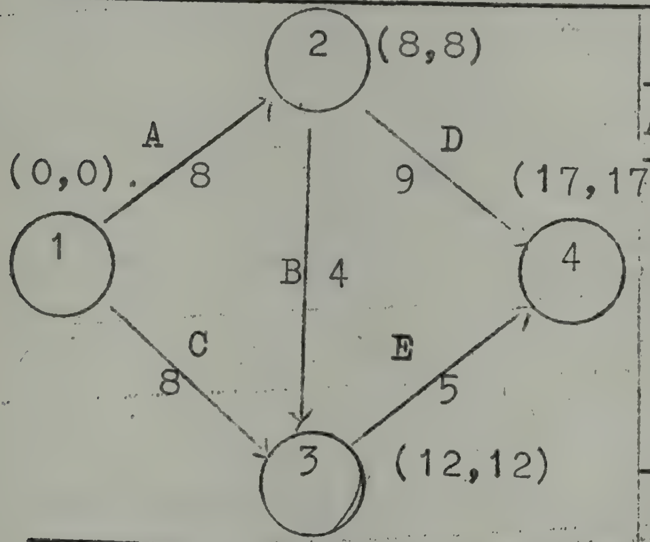
Project Time: 18

Project cost: 14,100

Decision:

Shorten B by 1 week

Schedule 3: Shorten B by 1 week from schedule 2




| Present | | | Plan | |
|---|---|---|---|---|
| Act | Week | Rs. | Crash | slope |
| A | 8 | 3,000 | 2 | 600 |
| B | 4 | 2,800 | 3 | 400 |
| C | 8 | 2,500 | 6 | 1000 |
| D | 9 | 5,000 | 9 | - |
| E | 5 | 1,200 | 2 | 900 |
| Total | | 14,500 | | |

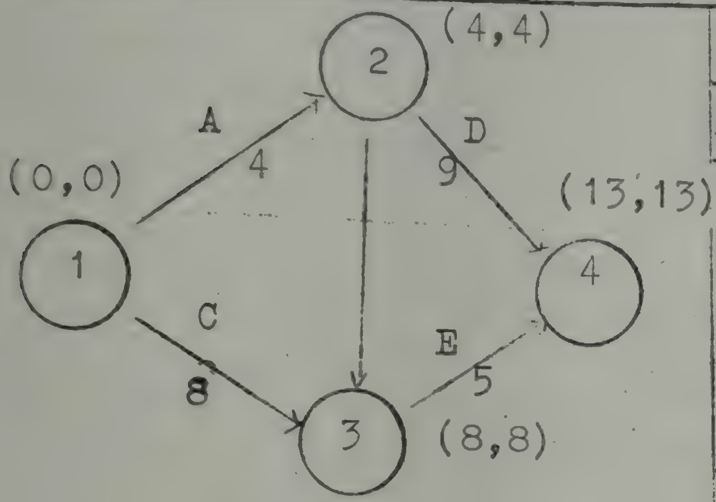
Project time: 17

Project cost: 14,500

Decision:

Shorten A by 4 weeks

Schedule 4: Shorten A by 4 week from schedule 3

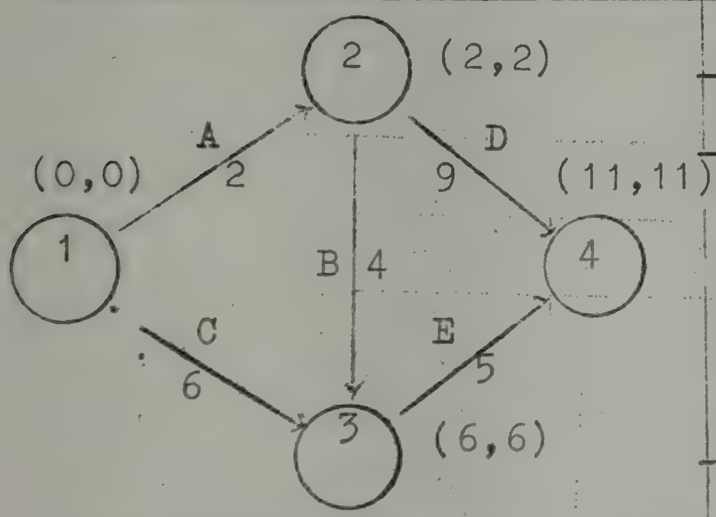



| Present | | | Plan | |
|---|---|---|---|---|
| Act | Weeks | Rs. | Crash | Slope |
| A | 4 | 5,400 | 2 | 600 |
| B | 4 | 2,800 | 3 | 400 |
| C | 8 | 2,500 | 6 | 1000 |
| D | 9 | 5,000 | 9 | - |
| E | 5 | 1,200 | 2 | 900 |
| Total | | 16,900 | | |

Project time: 13
Project cost: 16,900

Decision: Shorten A by 2 weeks & C by 2 weeks

Schedule 5: Shorten A by 2, C by 2 from Schedule 4

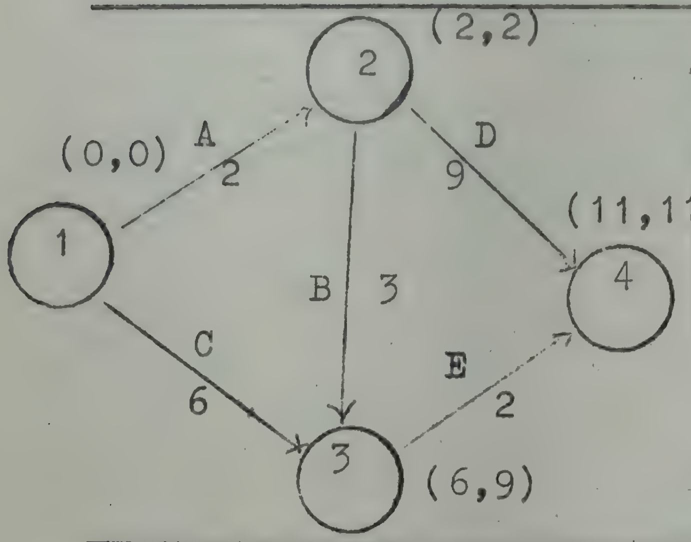



| Present | | | Plan | |
|---|---|---|---|---|
| Act | Weeks | Rs. | Crash | Slope |
| A | 2 | 6,600 | 2 | - |
| B | 4 | 2,800 | 3 | 400 |
| C | 6 | 4,500 | 6 | - |
| D | 9 | 500 | 9 | - |
| E | 5 | 1,200 | 2 | 900 |
| Total | | 20,100 | | |

Project time: 11
Project cost: 20,100

Decision:
Crash all activities

Schedule 6: Crash all activities




| Present | | | Plan | |
|---|---|---|---|---|
| Act | weeks | Rs. | Crash | Slope |
| A | 2 | 6,600 | 2 | - |
| B | 3 | 3,200 | 3 | - |
| C | 6 | 4,500 | 6 | - |
| D | 9 | 5,000 | 9 | - |
| E | 2 | 3,900 | 2 | - |
| Total | | 23,200 | | |

Project time: 11
Project cost: 23,200

Summary of calculations:

| Schedule | Time | Cost | | Cost Total |
|---|---|---|---|---|
| | | Direct | Indirect | |
| 1 | 19 | 13,700 | 9,500 | 23,200 |
| 2 | 18 | 14,100 | 9,000 | 23,100 |
| 3 | 17 | 14,500 | 8,500 | 23,000 |
| 4 | 13 | 16,900 | 6,500 | 23,400 |
| 5 | 11 | 20,100 | 5,500 | 25,600 |
| 6 | 11 | 23,200 | 5,500 | 28,700 |

## D. Use of CPM

One of the most difficult problems in using the Critical Path Method of planning and scheduling is the derivation of the normal and crash durations and costs for each activity. The normal durations and costs usually do not present as much of a problem as the crash estimates.

In general, the only way to arrive at realistic crash estimates is to critically analyse each activity and cost out of the possible ways of performing it. For example, when overtime and extra shift operations are permitted, several possible alternatives may have to be synthesized and costed.

Even when overtime and extra shift operations are not used, complexities may still arise. For the first project application of CPM by duPont, only a 40-hour week was authorised for the project. Crash times for various activities were obtained by considering only the maximum reasonable increase in manpower for each job and the effect on elapsed time. As the size of crew increased, additional costs were found necessary because of the extra labour congestion. The crash cost was obtained by adding the extra labour costs to the normal cost with an allowance for labour congestion.

The cost-time curve for some types of activities is purely approximated by a straight line between the crash and normal points. For example, consider transportation type activities for which there may be only two rates: a normal rate and a premium or expedited rate. In such cases, the curve consists of only two distinct points, and to connect these points by a straight line is meaningless since there are no possible transportation times between the normal and expedited times. For other types of activities, the cost-duration curve may consist of a succession of discrete points and the use of a value between any two points would correspond to an impractical time-cost relationship.

In practical applications, it has been observed that approximately 10 to 20 per cent of the activities in a network are critical, and that the majority of activities are

scheduled at their normal time. Only a few activities are scheduled at durations corresponding to their crash cost, and the others are expedited to times between the normal and crash durations. These observations led to the conclusion that much of the time-cost data was not being used in the computational procedure. As a result of this conclusion and the fact that construction of time-cost relationships is often quite burdensome, the technique has been modified to a "cut-and-dry" or sequential computational method. With the modified CPM technique, the network plan is prepared in the usual manner durations and costs are estimated for each activity. The project direct cost is computed and the net-work is analyzed using the normal time durations to determine the critical path and the various slack paths. The indirect cost associated with the computed project duration is also computed and a point on the project cost curve determined. Next, the activities on the critical path are analyzed in detail, and time-cost data collected for expediting these activities by small time increments. The CPM technique is now employed to expedite the activities on the critical path. The resulting project duration direct cost and total cost are again computed. The procedure is repeated with time-cost data collected for activities as they become critical, and for as long as the project total cost decreases. When total project costs begin to increase, the procedure can be stopped because the optimum project duration and cost has been reached.

The step approach offers the following advantages:

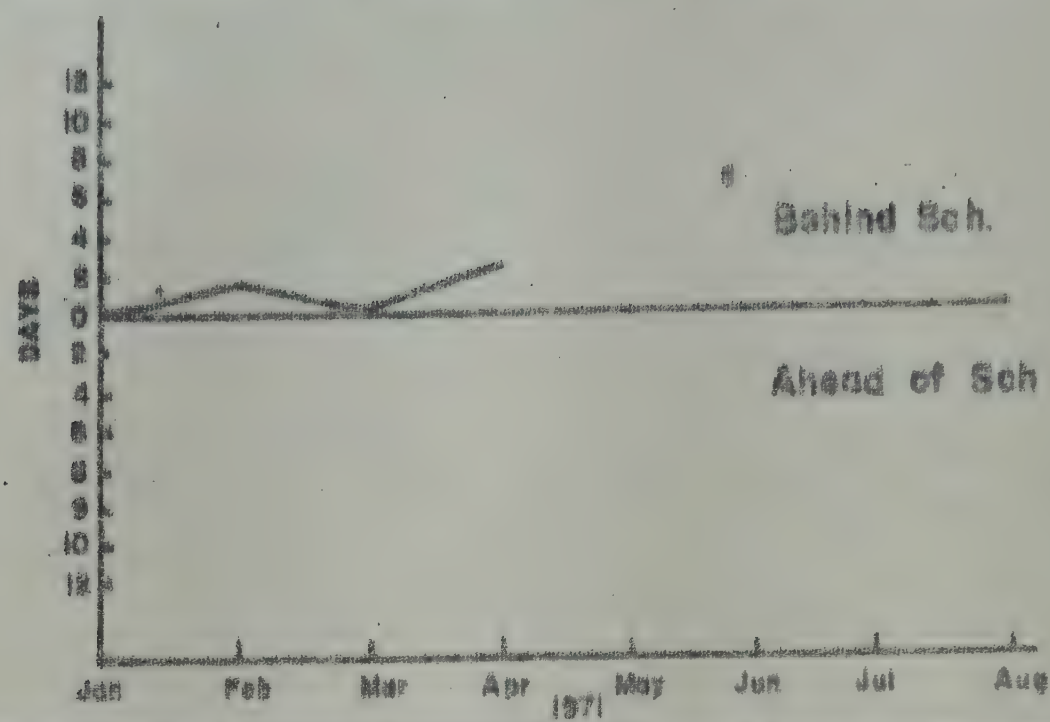
1. Less effort is involved since estimates of crash and durations are not required for all activities.

2. The provision for review after each computational cycle offers an opportunity for better understanding of the manner in which activities are expedited to achieve successive comprehensions in project duration time.

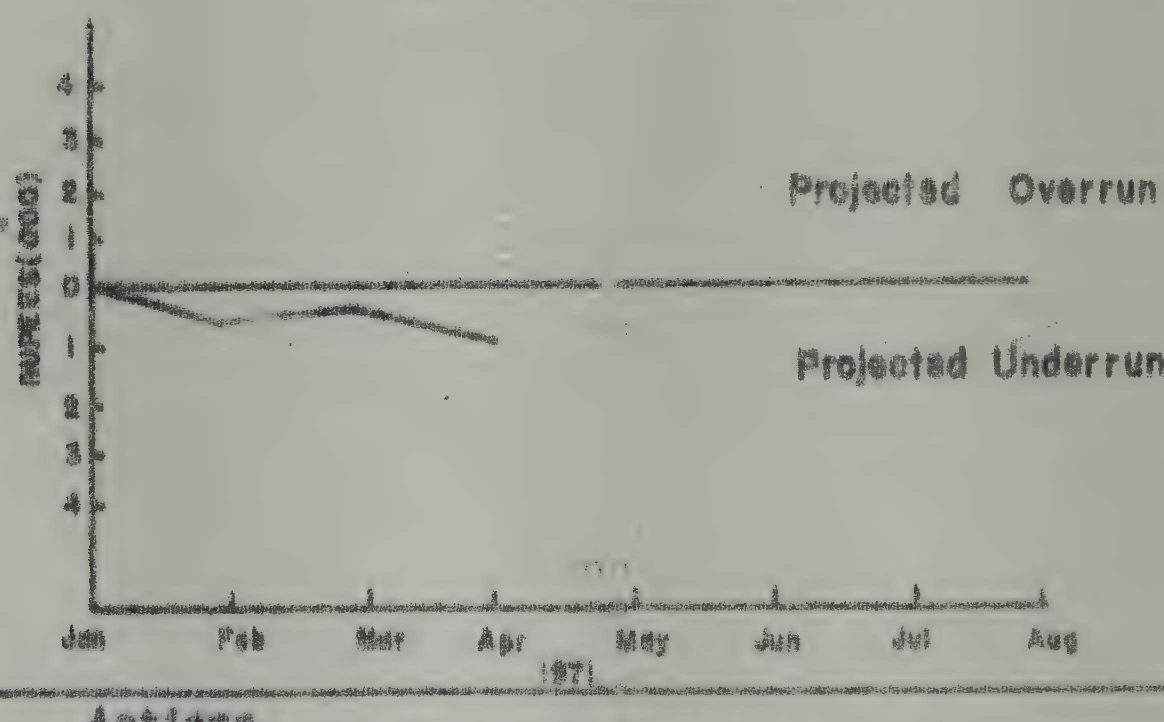
3. A smaller computer and a much simple programme can be used. The complete technique with the minimum cost expediting feature is not easily programmed and requires a large scale computer.

Illustrations of schedule/cost outlook and cost time status have been given in fig. 15.3 and fig. 15.4 respectively. The specimen pro forma for programme status report has been provided on page 388.

## SCHEDULE OUTLOOK REPORT




## COST OUTLOOK REPORT

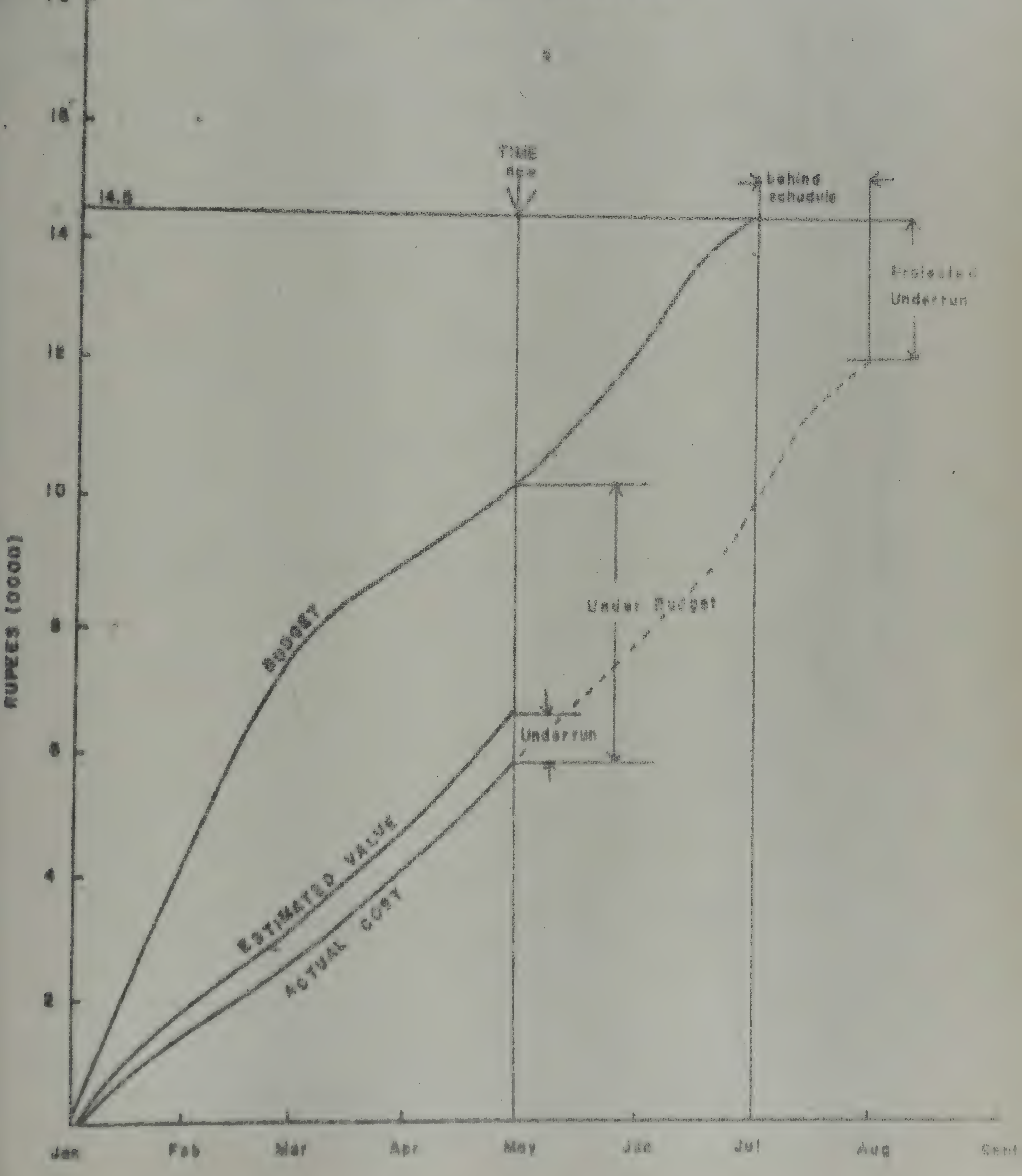



Actions

1. Reallocate funds to critical areas
2. Revise planned resources allocation
   - trade-off between critical and non-critical activities
   - increase/decrease planned resources
3. Revise network sequence or content
   - amount of concurrence
   - alter, delete, or add activities.

Fig. 13.3

# COST-TIME STATUS

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PROGRAMME STATUS REPORT

| ACTIVITY DETAILS | | date completed | earliest finish date | latest finish date | Float | actual cost so far | original estimate | revised estimate | overren/(under-run) |
|---|---|---|---|---|---|---|---|---|---|
| Name | Code | | | | | | | | |
| | | | | | | | | | |

Chapter XVI

# PROJECT FORMULATION AND EVALUATION-III

## PERT *

### A. Introduction

During 1957, the US Governmental agencies responsible for the development of Polaris Fleet Ballistic Missile were faced with the problem of coordinating the activities of several thousand contractors and agencies participating in the development programme. The conventional planning techniques using Gantt Charts did not provide them with a way to identify and achieve the optimum plan.

So the planners searched for new planning techniques. The result of their search is the "Programme Evaluation and Review Technique" (PERT). The entire programme was portrayed as a network of activities. They also found that PERT can be used very effectively to monitor and control the progress. The successful way in which PERT was used for Polaris programme, encouraged many other governmental agencies and private industries to adopt it.

The primary objective of PERT is to determine the probability of meeting specified deadlines.

Simultaneously, the private industries participating in complex developmental activities were searching for better planning tools to determine a plan yielding optimum cost. Coincidentally, they too came up with a network technique CPM (Critical Path Method). ...

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The main objective of CPM is to determine a schedule at 'minimum' cost.

During the past decade the term PERT is used to denote the network approach to planning where both time and cost are taken into consideration.

## B. Network

A project or programme is represented as a network of activities in PERT. The network does not merely portray the activities. It presents them in a logical sequence identifying activities that can be done simultaneously and their chronological sequence.

### 1. Definitions:

Activities: are definite tasks which are necessary to complete a project. They use resources, cost money and consume time. Each activity is represented by an arrow.

Event is a recognisable moment in time when a certain objective is achieved. An event, for example, can be the completion or start of one or more activities. Every activity begins and ends in an event. Each event is represented by a circle.

Network is the graphical portrayal of a project. It is drawn by connecting the various events by appropriate activities, indicating which activities can be done simultaneously, and which necessarily must follow in sequence.

A dummy activity is an activity, consuming no time and requiring no resources, deliberately introduced by the planner to maintain proper relationships between related activities. A dummy activity is represented by a broken line.

2. Points to be noted:

An event is achieved when all the activities leading to it are completed.

An activity can start only after its starting event has been achieved.

Any one path of activities should not include an event more than once. In other words, no looping is allowed. (fig. 16.1).

3. Example 1:

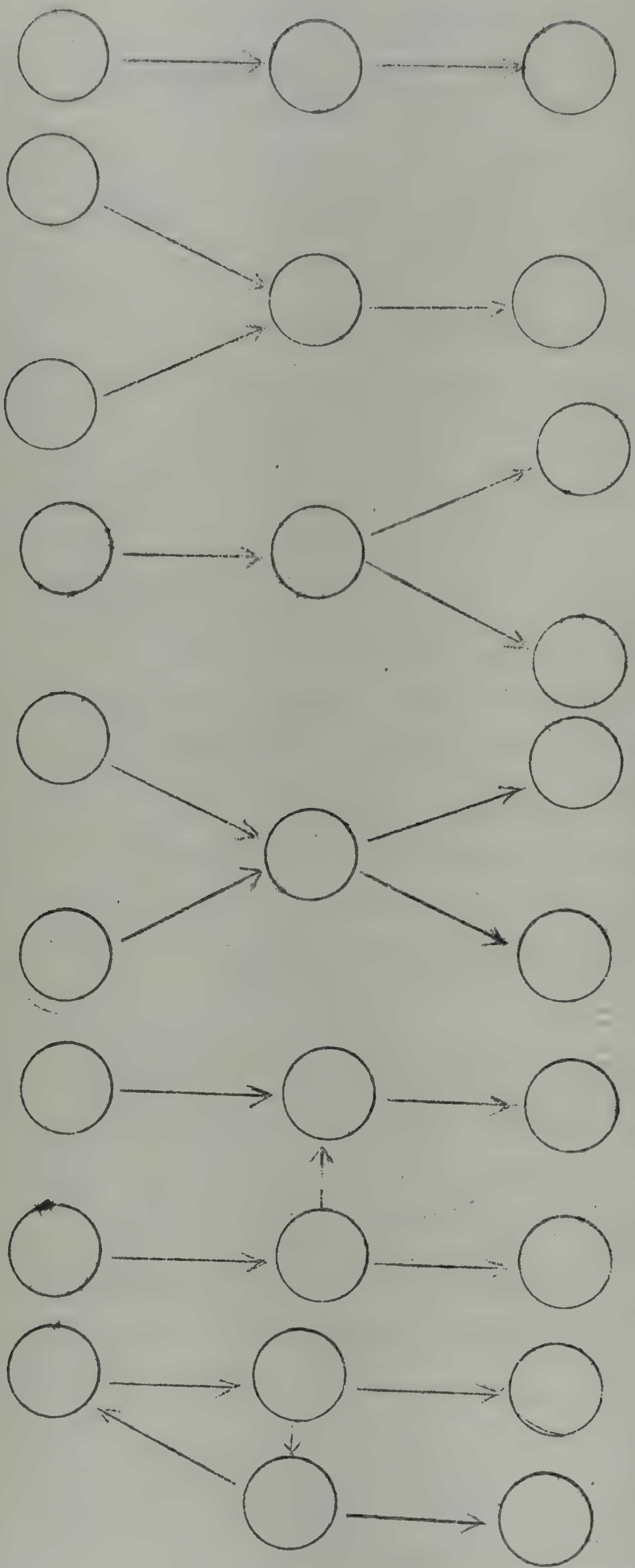
A petrol bunk operator desires a network to represent all activities to be performed on an incoming car. The services offered are: cleaning wind shields, check tyres, check oil, check battery and check petrol tank. For the purposes of drawing the network he assumes that all activities are performed. If any one or more activities need not be performed he will assign a zero time value for those. The activities are listed below. Draw the network.

Activities:

| | | | |
|---|---|---|---|
| A | Raise Bonnet | F | Check oil |
| B | Add petrol | G | Lower bonnet |
| C | Check tyres | H | Clean windshield |
| D | Check radiator | I | Compute bill |
| E | Check battery | J | Collect payment |

Example 2:

A network of the following steam pipe maintenance project has to be drawn. The project begins by moving the required material and equipment to the site (5 hrs). Then we may erect a scaffold and remove the old pipe and valves (3 hrs); while this is being done, we may fabricate the new pipe



Activity A must be completed before activity B can start.

Activity C cannot start until both activities A and B are completed.

Activities B and C cannot start until activity A is completed.

Activities C and D cannot start until both activities A and B are completed.

Activities A and B must be completed before activity C can start. However only activity B must be completed before activity D can start. (note use of dummy)

Improper network; since A,C,B form a loop.

Fig. 16.1: Basic logic of network notation.

(2 hrs). After the old pipe and valves are removed and the new pipe is fabricated, we can place the new pipe (4 hrs). However, the new valves can be placed (1 hr) as soon as the old line is removed. Finally, when everything is in place, we can weld and insulate the pipe (5 hrs).

## C. Activity Time Estimates

How long does it take to perform a specific activity? One can answer this with some confidence if he has performed the same activity once or twice before. Even then he cannot be fully sure and give an estimate that will be exact. In other words, there is always a certain amount of uncertainty involved in such estimates. Any effective planning technique must have a way by which the uncertainty can be quantified and evaluated. PERT does this by asking that three time estimates be made for each activity. They are:

the most likely time = m
the pessimistic time = b
the optimistic time = a

These estimates are to be made by persons most familiar with the activity involved.

### 1. Interpretation of the three time estimates:

Optimistic time is an estimate of the minimum time an activity will take. This can be realised only if unusual good luck is experienced and everything works out right the first time.

Most likely time is an estimate of the normal time an activity will take. If the activity could be repeated a number of times under similar circumstances, this result will occur most often.

Pessimistic time is an estimate of the maximum time an activity will take. This will occur only if unusual bad luck is experienced. This estimate is given by taking into consideration the possibility of initial setbacks, failures and consequent re-starts. However, this must not reflect such factors as strikes, fires, etc., unless such are inherent risks in the activity.

2. <u>Expected time estimate</u>:

The manner in which the three time estimate are defined, it is clear that the optimistic and the pessimistic times should occur rarely; and that the most likely time should occur often. Giving more weight to the most likely time and assuming that the time estimates follow a beta distribution, the expected time is defined as

$$t_e = \frac{a + 4m + b}{6}$$

Since a and b are the two extreme values, it is assumed that the rage (b-a) is equal to six times the stand duration.

Hence

$$\sigma = \frac{b - a}{6}$$

Even though these assumptions appear arbitrary, many studies conducted to test the validity of these assumptions have proved they are valid indeed. Also, they have been proved to be valuable in many successful applications.

## D. Preliminary Data

The steps taken so far are summarised below: The data collected can be presented in the tabular form shown in PERT Form 1

1. Identify all activities
2. For each activity identify the immediate predecessors
3. Using a logical approach organize the activities into a network
4. For each activity, obtain time estimates a, m, and b, and calculate expected time and standard duration. Also calculate the variance (= square of the standard deviation for each activity).

PERT Form 1

| Activity | | List Predecessors | Time Estimate | | | | Std Dev | Var |
|---|---|---|---|---|---|---|---|---|
| Code | name | | a | m | b | Te | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | | | | | | | | |
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## E. Network Analysis

### 1. Definitions - Event oriented

Earliest time for an event is defined as the time at which that event will occur if the preceding activities are started as early as possible. The earliest time for the i-th event is denoted by $E(i)$.

Latest time for an event is defined as the time at which the event can occur without delaying the completion of the project beyond its earliest time. The latest time for the i-th event is denoted by $L(i)$.

Slack for an event is the difference between its latest time and earliest time. The slack for the k-th event is denoted by $S(k)$ and is given by

$$S(k) = L(k) - E(k)$$

Critical Path for the project may be defined as a path through the network such that all the events on this path have zero slack.

Project time is given by the earliest time of the last event in the project network.

### 2. Definitions - Activity oriented

Earliest start time for an activity is the earliest time at which it can be started if the preceding activities are started as early as possible. This is denoted by $ES(i,j)$ which is read as Earliest Start for activity $(i,j)$ and is given by

$$ES\ (i,j) = E(i)$$

Duration of an activity is given by the expected time ($t_e$) in which an activity will be completed. d(i,j) denotes the duration of the activity (i,j).

Earliest Finish time for an activity is the sum of its duration and its earliest start time. This is denoted by EF(i,j) and is given by

$$EF(i,j) = ES(i,j) + d(i,j)$$

Latest finish time for an activity is the latest time an activity can be finished without delaying the completion of the project beyond its earliest time. This is denoted by LF(i,j) and is given by

$$LF(i,j) = L(j)$$

Latest start time is the latest time an activity can be started without delaying the completion of the project beyond its earliest time. This is denoted by LS(i,j) and is given by

$$LS(i,j) = LF(i,j) - d(i,j)$$

Total float is the amount of extra time available to complete the activity if it is started as early as possible and if it is completed as late as possible without delaying the completion of the project beyond its earliest time.

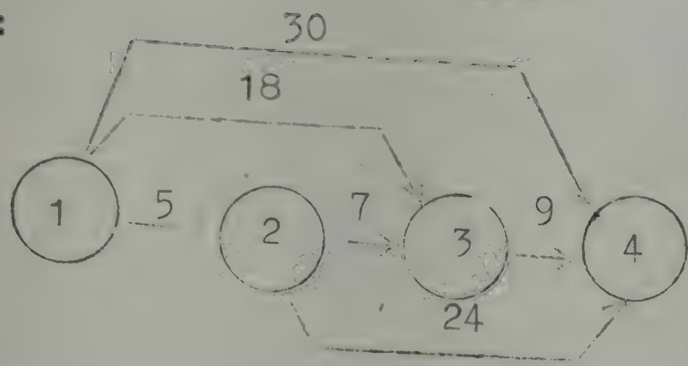
$$TF(i,j) = E(j) - EF(i,j)$$

Free float is the amount of extra time available to complete the activity if all activities are to be started at their respective earliest times.

$$FF(i,j) = E(j) - EF(i,j)$$

Independent float is the float (free time) available to an activity independent of the other activities. It is

3. Example:




| a | b | c | d | e | f | g | h | i | j |
|---|---|---|---|---|---|---|---|---|---|
| Event No. | Immediate Predecessor | | | Earliest Time | Immediate Successor | | | Latest time | Slack |
| | Event No. | Expected value | Earliest time | | Event No. | Expected value | Latest time | | |
| i | j | d(j,i) | E(i) | E(i) | k | d(i,k) | L(k) | L(i) | S(i) |
| 4 | 1<br>2<br>3 | 30<br>24<br>9 | 0<br>5<br>18 | 30 | | | | 30 | 0 |
| 3 | 1<br>2 | 18<br>7 | 0<br>5 | 18 | 4 | 9 | 30 | 21 | 3 |
| 2 | 1 | 5 | 0 | 5 | 3<br>4 | 7<br>24 | 21<br>30 | 6 | 1 |
| 1 | | | | 0 | 2<br>3<br>4 | 5<br>18<br>30 | 6<br>21<br>30 | 0 | 0 |

| (i,j) | d(i,j) | E(i,j) | EF(i,j) | LF(i,j) | LS(i,j) | TF(i,j) | FF(i,j) | IF(i,j) |
|---|---|---|---|---|---|---|---|---|
| (1,2) | 5 | 0 | 5 | 6 | 1 | 1 | 0 | 0 |
| (1,3) | 18 | 0 | 18 | 21 | 3 | 3 | 0 | 0 |
| (1,4) | 30 | 0 | 30 | 30 | 0 | 0 | 0 | 0 |
| (2,3) | 7 | 5 | 12 | 21 | 14 | 9 | 6 | 5 |
| (2,4) | 24 | 5 | 29 | 30 | 6 | 1 | 1 | 0 |
| (3,4) | 9 | 18 | 27 | 30 | 21 | 3 | 3 | 0 |

computed by assuming that the activity is started at the latest start time and yet completed before the earliest time for its end event.

$$If(i,j) = E(j) - L(i) - d(i,j)$$

4. <u>Analysis</u>:

The example given in E-3 has brought out all the necessary steps to be taken in analysing a network. If the network is large, then the format used in the examples will not be convenient. Hence, formats 2 and 3 are developed to perform the necessary calculations in an orderly manner.

<u>Procedure for using PERT Form 2</u>:

1. Identify sink (last event)
2. Treat this as event i and enter i in column (a)
3. Identify all the events immediately preceding i and list them in column (b)
4. Treat as event j the first event in column (b) against i. Enter the duration d(j,i) in column (c) and the variance

$\sigma$ (j,i) in column (e). Repeat this for all j events listed against i.

5. Select event (i-1). If (i-1) = 0 go to step 6; otherwise draw a line below the last entry and go to step 2.
6. Against event 1 enter in columns (g) and (h) a value of 0, i.e., E(1) = 0 and $\sigma^2$ (E1) = 0.

   Consider event 2.

7. Treat this as event.
8. Treat each event in column (b) as j. Obtain earliest time E(j) from column (g) by visual search and enter it in column (d). Repeat this for all j events listed against event i.

PERT Form 2

| Event i | Immediate Predecessor | | | | | Earliest time E(i) | Variance $\sigma^2(E_i)$ |
|---|---|---|---|---|---|---|---|
| | Event No. j | Expected value d(j,i) | Earliest time E(j) | Variance $\sigma^2(j,i)$ | Variance $\sigma^2(E_j)$ | | |
| a | b | c | d | e | f | g | h |
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PERT Form 3

| Event No. i | Immediate Successor | | | | | Latest time | Vari-ance | Earliest time | Slack |
|---|---|---|---|---|---|---|---|---|---|
| | Event No. k | Ex-pected value d(i,k) | Latest time L(k) | Vari-ance $\sigma(i,k)$ | Vari-ance $\sigma(Lk)$ | | | | |
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9. For each j, add columns (c) and (d). Enter the maximum value in column (g). Select the event j which gives this maximum value. For this j find the sum of $\sigma^2$ (j,i) and $\sigma^2$ (Ej) and enter the sum in column (h)

10. If i is the sink, go to step 11; otherwise select event i + 1 and go to step 7.

Procedures to use PERT form (3) will be similar to those given above. The fact that we are now trying to find out earliest time extent of the latest must be kept in mind.

5. Slack:

Slack for an event is the time by which that event can be delayed without delaying the completion of the project beyond the earliest time for the project. The extra time available for completing an activity is also called slack.

The planner can concentrate only on those activities having zero slack. These activities, as told earlier, form the critical path. Availability of positive slack for some activities allows the management to shift resources from those activities having positive slacks to those having zero slacks.

6. Planning:

If the earliest time for the project is more than the scheduled time within which the project must be completed, then one or two of the following must be done:

i) Application of additional resources by overtime or by increasing resources at extra cost;

ii) Rearranging certain activities (and the necessary resources), which were previously in series, in parallel, and

iii) Deleting, if possible, some of the comparatively less necessary articles.

7. Probability of meeting a schedule:

Consider the example given in E-3. The earliest time within which the project can be completed was found to be 30 days. We shall call this the project time. In probabilistic terms, what this means is that the project can be completed within 30 days with a probability of 0.5. In other words, we consider the earliest time obtained as the expected value of the project duration which is assumed to be distributed normally with this calculated time as the mean and the variance as given in forms 2 and 3.

Considering the same example we find that the project duration is distributed normally with a mean of 30 days. Since we have not calculated the standard deviation in that example, let us assume it to be 5 days. If the planner was told that the project must be completed within 35 days, he can proceed as given below:

| | | |
|---|---|---|
| mean | = | 30 |
| Std. deviation | = | 5 |
| T given | = | 35 |

Therefore, $Z = \dfrac{35 - 30}{5} = 1$

Referring to the table giving areas under normal curve we find that probability of meeting a schedule of 35 days is 0.8413.

PERT Form 4

| Event No. | Earliest time | | Latest time | | Slack | Original Schedule | Probability of meeting schedule |
|---|---|---|---|---|---|---|---|
| | Expected value $E(i)$ | Variance $\sigma^2(Ei)$ | Expected value $L(i)$ | Variance $\sigma^2(Li)$ | $S(i)$ | | $P(i)$ |
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PERT form-4 can be conveniently used for evaluating the use of the probability of meeting schedules on various milestones or important events.

## F. Examples in PERT Usage

The following examples are drawn from different sectors, each identifying certain unique problems. While drawing a PERT chart for any project the interdependency of various agencies and resources will automatically come to focus. The recognition of these interdependencies and the planning exercise one goes through in co-ordinating them is one of the major benefits of PERT.

Example 1: National Planning:

A country, having recently achieved independence, has drawn up its national plan for economic development. The first objective is in two parts:

a) establishment of heavy engineering industry, and

b) a 20 per cent increase in the area of arable land.

Electricity is essential to heavy engineering, and will be generated by hydroelectric stations. The cement needed for building the power stations and dams is to be manufactured locally, in factories to be financed by World Bank loan. Water from the dams will be taken in concrete conduits to the barren areas for part 'b' of the plan. Part of the loan will be used to build a fertilizer factory, which will also contribute to part 'b' of plan. Cement will be imported for building the fertilizer and the cement factory.

Let us draw a network for this part of the plan. (Some of the points brought out are:

i) different levels of network - from highly condensed to extremely detailed;

ii) level of planning resources needed;

iii) time constraint for national planning;

iv) identification of approximate time-schedule and policy for importing cement; and

v) above all, it provides a framework for having rational discussions (instead of off-the-cuff) towards a feasible plan. The network is shown in fig. 16.2.

Example 2: Appointment of Land Commission by Parliament:

The Ministry of Land and Natural Resources of UK was set up in October 1964 by the newly elected Labour Government. One of the specific tasks of the Ministry was to give effect to the pledge in the Labour Party's manifesto that it would:

" .... set up a Land Commission to buy, for the community, land on which building or rebuilding is to take place .... ".

An outline network has to be drawn up to bring out the inter-relationship of the main activities and to see what could be established initially about the completion date.

After a series of planning meetings the following main activities are identified for "appointing the land commission".

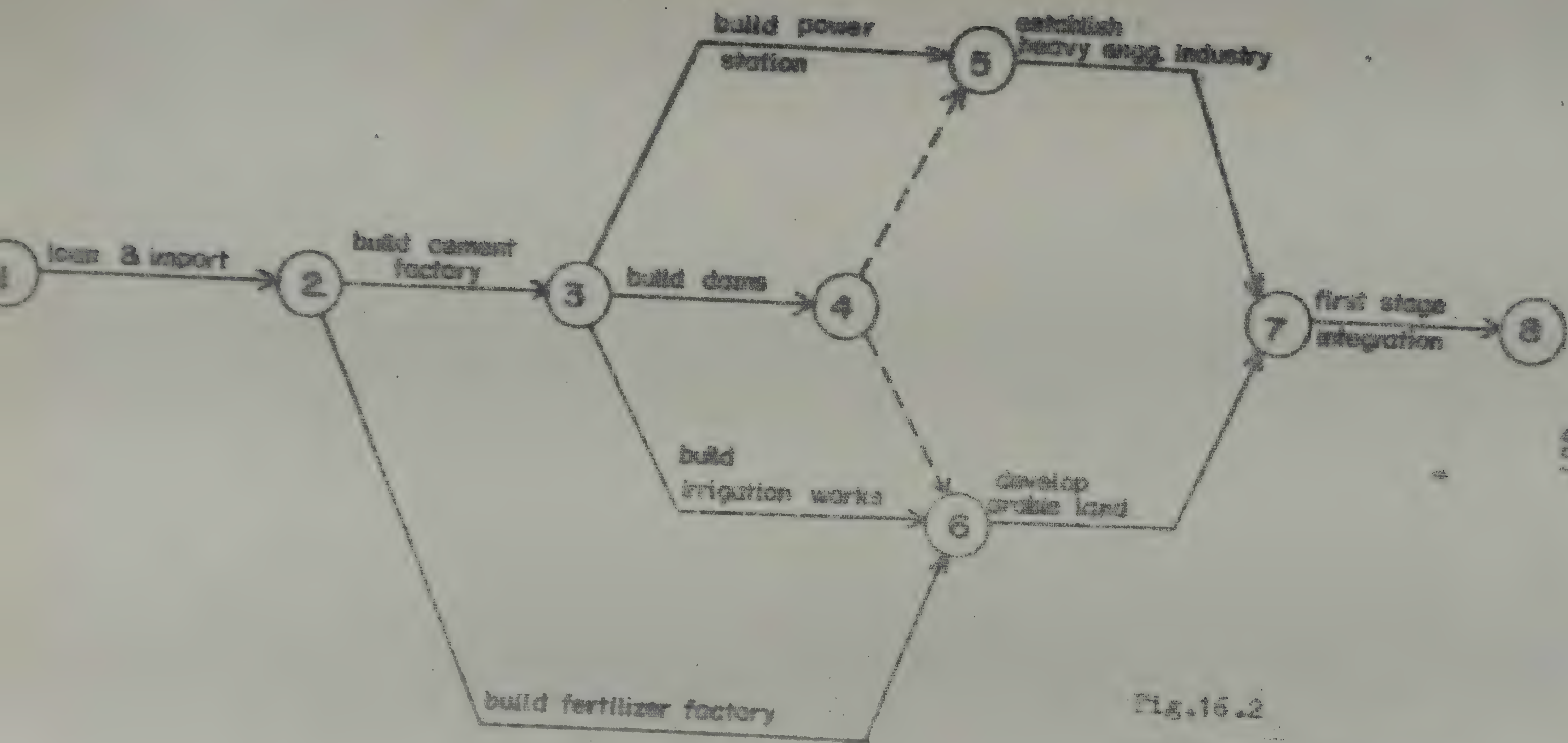


Fig.16.2
NATIONAL PLANNING

| Code | Activity Description | Immediate Predecessor |
|---|---|---|
| A | Prepare bill | - |
| B | Prepare white paper | - |
| C | Set up project team | - |
| D | Bill before Parliament | A,B |
| E | Appoint Commission | D |
| F | Design system | C |
| G | Assess staff | C |
| H | Assess EDP requirements | C |
| I | Recruit staff | G |
| J | Assess accommodation required | G |
| K | Search for accommodation | J |
| L | Order, receive, install EDP | H |
| M | Print forms | F |
| N | Distribute forms | M |
| O | Trials | F |
| P | Finalise accommodation | K |
| Q | Train staff | I,P |
| R | Test EDP installation | L |

The network is shown in fig. 16.3.

The PERT analysis brought out the following points:

i) The scale of work, on the estimates available, was such that a total staff of over 1,000 was likely and, on grounds of efficiency alone, there was a case for establishing the Commission in a number of offices rather than in one central office;

ii) The need to make the Land Commission effective at the earliest possible date, it was suggested that office accommodation either existing or in course of erection would be used;

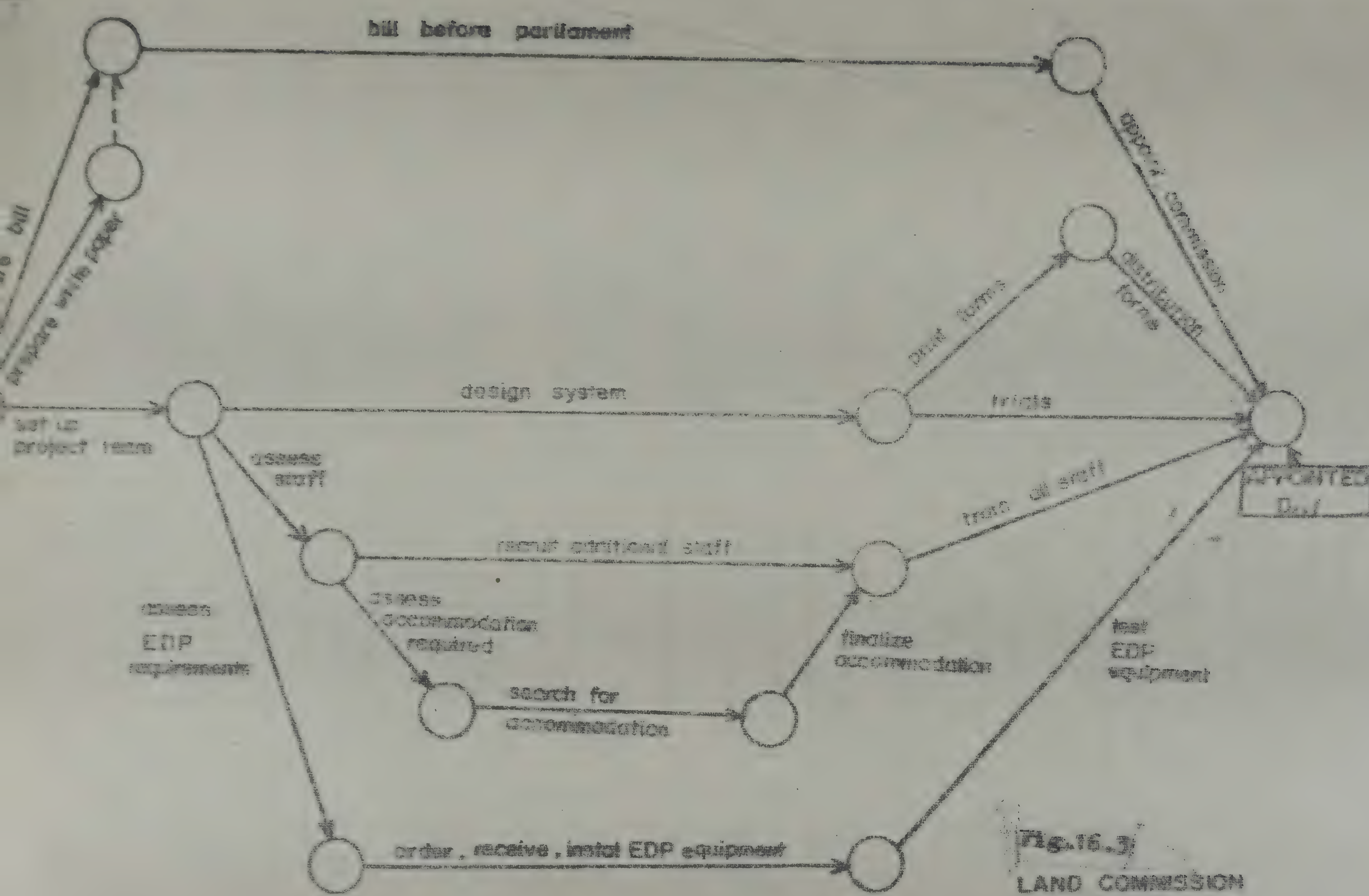


Fig.16.3
LAND COMMISSION
APPOINTMENT

iii) The need for urgency also ruled out the case for installing a Land Commission computer de novo, which the scale of operations appeared to require. The use of a computer service bureau was indicated. It was assumed that computer service bureau capacity would be used;

iv) It was assumed that the staff would be drawn mainly from the Civil Service but there would also be some direct recruitment. All would require training;

v) It was desirable that offices should be available and that staff should be in post sometime before the Appointed Day so that the staff might become acquainted with each other and their surroundings. It was possible that this step could coincide with the training stage; and

vi) It was assumed that the day-to-day planning of the project would be carried out by a Project Team reporting to a Steering Committee consisting of senior officers of the Ministry of Land and Natural Resources.

Example 3: Dry farming sector - DPAP and initial planning:

The DPAP plan for a district involves the participation of many sectors. As an example the over-all plan for dry farming is taken up here.

The first activity will be "Resources Analysis and Sectoral Identification". This activity requires the participation of all the sectors. In this example this will be treated as a single activity. However, it will be necessary to develop the detailed PERT chart even for this activity if we want to make effective use of the time and personnel available at the district level.

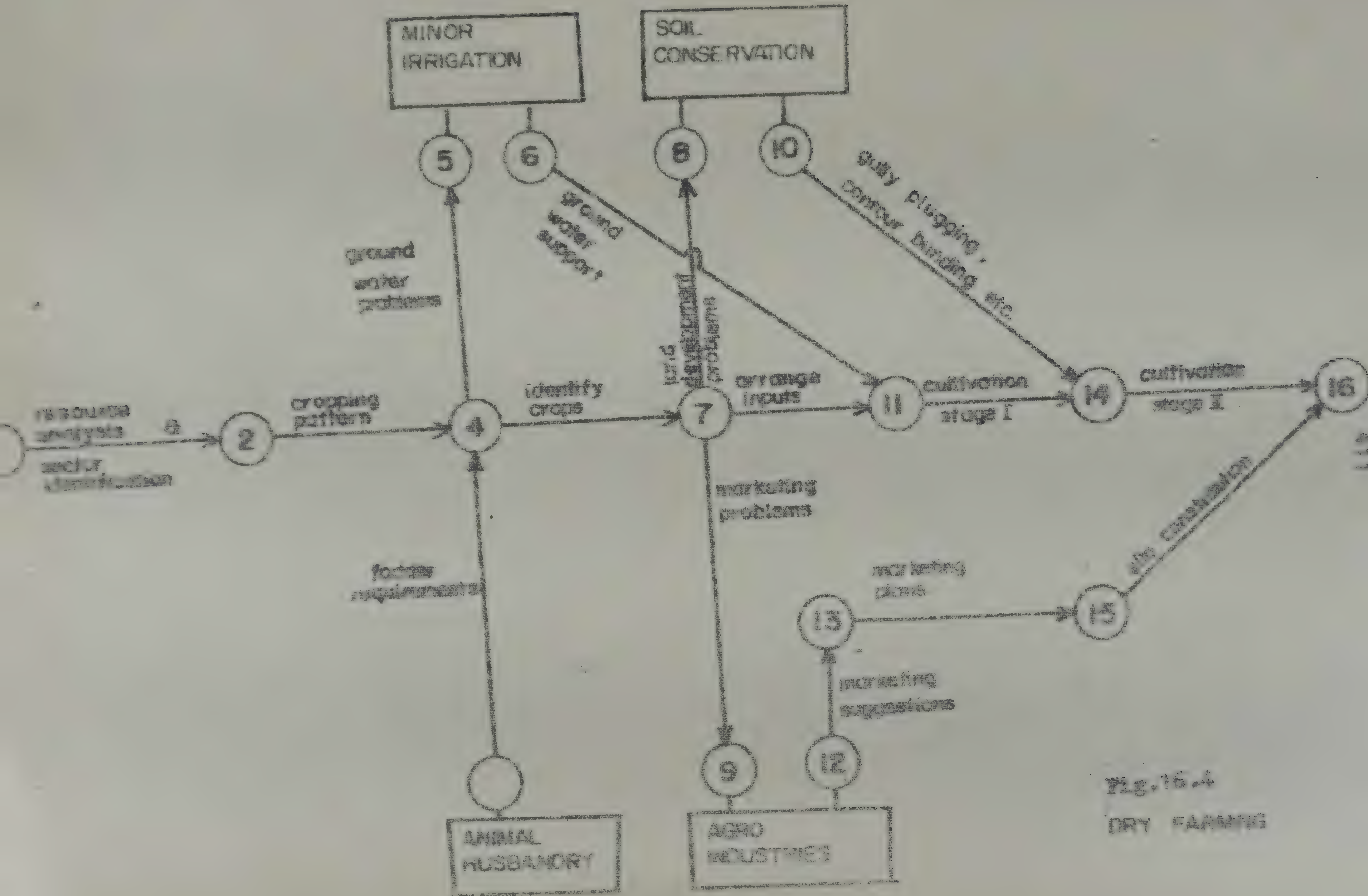


Fig. 16.4
DRY FARMING

The second activity will be done by dry farming sector and is titled here as "Cropping Pattern Studies". The third activity is to identify crops. To do this, we also need information from the animal husbandry sector regarding their fodder requirements. Therefore starting on this we must work with the minor irrigation sector regarding the tapping of the ground water potential in that area.

Similarly there are many inter-relationship between dry farming and agro-industry corporation and soil conservation sector. The first stage of drawing the network is shown in fig. 16.4. This must be used as a starting point for detailed planning, including timing.

Chapter XVII

## PROJECT FORMULATION AND EVALUATION-IV: COST-BENEFIT ANALYSIS*

Cost benefit analysis is a very useful tool of analysis with wide-ranging application. The basic notion in this analysis is very simple. If a certain project is to be undertaken we need to use resources which are scarce. In other words, we cannot do everything that we would like to because the resources that we require are scarce whereas the things we would like to do are practically innumerable. Secondly, resources are not only scarce, they have alternative uses. Every resource can be used for more than one purpose. Therefore how do we decide whether a certain project should be undertaken?

Next, we cannot undertake a project unless it is feasible in the sense that it will yield an appropriate return. That is, no project is worth undertaking unless its benefits exceed its costs. Further if we decide to undertake one particular project (call it A) it means that we have to give up another project (call it B). If we do A, we lose the benefits of B. These benefits which we lose really are the cost of doing A.

At this point it is convenient to become familiar with a term often used in economics, namely, opportunity cost. Opportunity cost is the cost of not doing a particular thing. Suppose we have a choice among doing A, B, C and D with limited resources. The choice finally lies between A and B. We decide on A. B is the nearest alternative but we forego it. B is the opportunity cost of A.

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If this principle behind cost-benefit analysis is so simple, one may wonder why it is to be treated at great length. The fact is that there are plenty of problems connected with the measurement of costs and benefits. Precisely what should be included under costs and benefits is a highly controversial matter. Secondly, how they should be quantified and measured is another tricky issue. Unless we have some common demoninator, it would be impossible for us to compare two alternative projects. For our purposes, it is not necessary to go into these issues in detail. What we shall do is to consider the main principles behind what items are germane to a particular technique known as the discounted measure of estimating the return from a project.

## A. Basic Issues

### 1. Definition of a project:

Generally, the nature of the project being analysed is clear. But sometimes complications arise. Let us assume, we are analysing project A. The goods produced by this project may be related to some other goods, say, those produced by project B. Take another example: there is a river valley authority responsible for a long stretch of river. If a dam is constructed at a point upstream, this will affect the operations of existing or potential dams downstream. In all such cases, in calculating the costs and benefits of a particular project, allowances must be made for these side-effects. In jargon we say that where there are strong relationshipson either the supply side or the demand side, allowances must be made for them in cost-benefit calculations.

### 2. Externalities:

In the case of most projects, there are costs and benefits which accrue not to the persons/authority

responsible for the project but to a third party. Let us take a hypothetical illustration. A state government builds a reservoir upstream along an inter-state river. As a result the lower riparian state has to go in for more dredging. This has to be taken into account while calculating cost and benefit. The reason is that in this case the action of the upper riparian state has led to an alteration in the physical production possibilities of the lower riparian state from the river. Wherever this happens, the external effects of a particular project are taken into account.

In some cases, the external effects operate not directly as illustrated above but through the prices of products or of factors of production. Assume that a highway is improved. One result of this is that garages and restaurants along the highway become more profitable. They begin to employ more workers. They pay higher rents to the landlords of their premises. These benefits are not taken into account. They are not credited to the investment on the highway. The increase in profitability is a result of the fact that more journeys are now performed on the improved highway. It would be double counting if the extra trips plus their efforts are taken into consideration. It need hardly be stressed that it is never easy to make this distinction and there will always be borderline cases.

3. Secondary benefits:

What has been said above would indicate that pecuniary (monetary) spillovers (side-effects) are generally not taken into account. But there are some cases where it is held, they should be included in the estimation of benefits. As usual we shall use an illustration to grasp

this point. There is an irrigation project. On completion, this leads to an increase in grain production. The increased output leads to greater activity by merchants, transport companies, etc. It leads to an increase in their profits. Should these secondary benefits be taken into account? One view is that these should be but not certain other secondary benefits (known as induced secondary benefits) which arise from extra profits made out of activities. Some authors are critical of this view. The most acceptable compromise is this: If the output of a project has a market value (irrigation leads to increase in food grain production and this has a market value) then the problem is somewhat simplified. In our example, the worth of irrigation water to farmers is worked out as follows: The water makes possible increased grain production. The worth of the water to the farmers is the excess of the value of the increased output (made possible by the water) over the cost of the increase in the other inputs of the farmers. This is because when water is made available, the farmers will also have to incur extra cost over other inputs.

4. Project life:

Estimating the life of a project is another complex issue. This problem is discussed again below with reference to the discount rate. It should be noted that estimating the length of life is a subjective process and depends upon changes in technology, emergence of competitive products, changes in demand for the output of the project, etc.

We shall now turn to an examination of the selection of values in cost-benefit analysis.

5. Selection of values:

If costs and benefits are to be compared, they must be valued. The common denominator for valuing our commodities is money. The price of commodity is its value expressed in terms of money. Therefore, if costs and benefits are to be valued, it means that we must find the proper prices at which they should be compared.

6. Prices reflect values:

As mentioned above, the price of a commodity reflects (or should reflect) its value. The problem is that due to a number of reasons the market price of a commodity may not reflect its value. One of the reasons is that prices accurately reflect values only when the market is perfect or near perfect. There is a whole body of literature in economics dealing with perfect markets. For our purpose the bare essentials will do. A perfect market is highly competitive, it has many buyers and sellers. In such a market, every commodity is priced at its marginal value product. All that this means is that the price of every commodity will reflect the value which the last unit of that commodity contributes to production. For example, the price of labour (wages) will be exactly equal to the contribution made by the last worker employed to the output. If a factor of production can earn more in some other activity,its price will rise and it will be attracted to that activity. Prices not only reflect values but allocate scarce resources among competing uses. The price mechanism (also referred to as the market mechanism) is supposed to perform this function. In a situation where the country is in "equilibrium", the marginal value product, the price of the commodity and its opportunity cost-what can be

earned by the commodity in the next best alternative use - all these will be equal. In such a situation, resources are optimally allocated. Nothing would be gained by transferring any resource from one use to another.

In actual fact, such perfect markets rarely exist. Therefore, prices do not accurately reflect value. For example, in an underdeveloped country, the price of capital (the rate of interest) may not truly reflect its scarcity. Hence entrepreneurs may use more capital than is actually warranted. Although we know that often prices do not accurately reflect values, we cannot abandon prices, that is, market prices altogether. There is an alternative to market prices known as shadow prices or accounting prices which is discussed below. That again is a highly controversial matter and economists are sharply divided on their use. In most cases, it is better to find the appropriate market price rather than an alternative (shadow) price. Perhaps what is required is an attempt to find the correct market price rather than replace it with some other notionally more accurate value. This is recommended although we realise that prices are often proved to be inaccurate.

The next problem to tackle is this; if you decide to use market price, you are still confronted with a choice among several alternatives such as point of first sale, farm gate price, etc. Let us consider each of these briefly.

7. Point of first sale:

The point of first sale is, under normal conditions, the best price to use. If the market for the commodity in question is relatively competitive and if the market price

can be accepted as a reasonably accurate reflection of value, then the price at the point of first sale can be taken as a good measure of this value of output.

8. Intermediate goods:

In many productive activities we come across intermediate goods. These are used as inputs and are not freely sold. An example of this is irrigation water. This means its price is not determined by market forces but by administrative decision. In this case, we cannot separate the irrigation system from the production which it helps. If we tried such separation, we would be forced to determine the value of irrigation water - not an easy job. Therefore, what is generally done is that the value of the agricultural production at the point of first sale is taken as the basis for calculating the benefit from irrigation.

9. Farm gate price:

This is the price which the farmer gets when he sells his output at the boundary of his farm. In an agricultural project which is exclusively production-oriented, the farm gate price is the correct price to be considered. The product will no doubt acquire additional value when it is processed and marketed. But this is to be attributed to the marketing and processing service and not to the project itself. However, if the project includes marketing, we will then be concerned with the farm gate price, as well as the market price.

There is one difficulty that we must consider. It is not always possible to determine the farm gate price. In many cases, the only prices available may be those which include marketing and/or other services which are not to be included in the project proper.

Another complication is introduced by taxes and subsidies. A subsidy may be given in order to encourage local production and reduce imports. In some cases, a tax may be levied on exports. In all such cases, the price will not accurately reflect the true value of the product.

10. Seasonal Fluctuation:

Most agricultural commodities are subject to seasonal fluctuation. This raises a question: At which point, in the seasonal fluctuation, should we choose the price? The answer is to choose the farm gate harvest price at the peak of the harvest season. This will most likely be the lowest price during the cycle. The justification for this choice is as follows. During the cycle, prices will rise but at least a part of the increase in prices will be due to factors other than the farmers' productive activity. However, this ignores another important problem. Farmers are often forced to sell their output immediately after harvest in order to meet debts. In such a case, it is justifiable to select a higher price than the farm gate harvest price at the peak of the season.

11. Grades:

Agricultural commodities are often graded. Prices vary with grades. In picking the correct price for project analysis, we may have to make decisions regarding grades. Two solutions are possible here: one is to assume that even after a certain project is undertaken, farmers will produce almost the same quantity as before. But, in many cases, the very purpose of a project is to improve the quality of the product. In this case, the proper procedure is to select the average price expected for the improved quality to be produced.

12. Future prices:

During the lifetime of a project, commodity prices may change. The question is how to predict future prices. It is best to assume that past prices can be taken as a guide to future prices. This is reasonable since the likelihood of a change in relative prices is not very great.

13. Inflation:

This is a severe problem specially at present when most countries are experiencing quite severe inflationary trends. It is most realistic to assume that inflation will continue. Further, we may assume that all prices both on the cost side and the benefit side will rise uniformly by the same proportion. This means that we assume that their relative values are not altered. Therefore, although we know that future money prices will rise, we can value all future prices at present levels. A difficulty will arise only if we expect that some prices will rise more than others. In such a case, the relative structure of prices will be altered. For instance, inflation might affect costs more than benefits. In this situation, it is advisable to assume constant prices for all items except for those which we expect will be differentially affected by inflation.

14. Accounting (shadow) prices:

It has been mentioned above that markets are often imperfect. This is especially true of underdeveloped countries. Markets may be imperfect due to interference by middlemen (institutional factors), administrative controls, monopoly control, lack of communication regarding

prices between producers and sellers, and many other reasons. As a result, market prices may not reflect accurately the values of commodities. To overcome this, the use of accounting or shadow prices is recommended.

What are accounting prices? They are prices which would prevail if the market were in equilibrium. In other words, an accounting price is that price which would bring the supply of and the demand for a commodity into equality. I have mentioned above that the subject of accounting prices bristles with much controversy. We need not go into this in detail. It is enough to note that it is difficult to estimate the accounting price of any commodity. This is specially so because the price of a commodity, say, rice, is influenced not only by the supply and demand conditions in that market but also by conditions in other related markets, say, substitutes like wheat. It is extremely difficult to possess full knowledge of the whole matrix of prices; economists generally ignore institutional and social factors but these are important in underdeveloped countries.

There is a view that accounting prices rather than market prices are useful with regard to agricultural products in three areas - foreign exchange, commodities important in world market, and unskilled agricultural labour.

15. Foreign exchange:

In the case of foreign exchange it is advisable to use the rate of exchange which the central planning authority is using. This is necessary because an accounting

price for foreign exchange is used only so that inputs are valued properly. If differert projects use different accounting prices, the whole purpose would be defeated.

16. <u>World market prices</u>:

Generally world markets are more perfect than domestic markets particularly where the latter are protected. Hence for commodities which enter the world market in a big way, world market prices would be a better guide than domestic market prices.

17. <u>Labour</u>:

In a perfectly competitive market, the price of labour (wages) would be equal to its marginal value product. The following example illustrates this.

| Number of workers | Total number of units produced | Wage per day | Price of product |
|---|---|---|---|
| 10 | 50 | Rs. 4 | Rs. 2 |
| 11 | 54 | do | do |
| 12 | 57 | do | do |
| 13 | 59 | do | do |
| 14 | 60 | do | do |

It is seen from the above table that as the number of workers increases so does the total production. But each extra worker adds less and less to the total output. The 13th worker adds 2 units to the production. These 2 units fetch a price of Rs.4 which is exactly equal to the wage of the worker. If the 14th worker is employed he adds only 1 unit to the production. The value is Rs.2, but he

has to be paid a wage of Rs.4. Therefore, it does not pay the entrepreneur to hire him. Hence, he will stop at the 13th worker.

This neat little piece of theory does not always work. In countries like India, there is a surplus of agricultural labour. The addition of one extra labourer adds nothing to the output. In technical language, the marginal productivity of labour is zero. In such a situation, if the extra labour is removed from agriculture, the output will not fall. These workers could be put [illegible] to work somewhere else where they make a positive contribution to production. There is no cost involved in this transfer of labour from agriculture to some other occupation. Therefore, in project analysis, in economic terms, the proper price to charge would be zero.

It is extremely difficult to determine the true marginal product of agricultural labour. All that can be said is that in labour-surplus economies it tends to be near zero. There is another problem however; when surplus workers are taken away from a farm, the output may fall because those left behind do not put in extra work. The point is that when there are extra workers, the required work is being performed by too many people. It does not mean that too much labour is being used. It is that too many workers are putting in the required labour and no one is fully employed. Therefore, those left behind on the farm have to compensate by working harder. Keeping this limitation is mind, agricultural labour may be shadow priced at zero.

Yet another problem here is that agricultural employment is seasonal. Hence, almost everyone can find work

during the peak seasons. At such times, the marginal product is certainly not zero. The proper procedure here is to value agricultural labour on an annual basis. This can be determined by multiplying the wage when labour is scarce by the number of days in a year when labour can be considered to be reasonably fully employed. Assume that labour is scarce for 70 days a year and earns Rs.5 per day. Then the annual wage can be shadow priced at 5 x 70 = Rs.350. This would be reasonable even when we expect that labour is actually employed for 200 days a year.

In other cases - where we do not find disguised unemployment - (namely a situation where some people appear to be employed although they do not contribute anything to the output) agricultural labour can be priced at the wage it commands.

Finally, agricultural labour which is currently unemployed or underemployed may improve its position during and after a project has been completed. In such a case, we may initially shadow price agricultural labour at zero; later we shadow price it at half the annual wage. Finally, we use the actual wage rate. This system of shadow price is generally applicable to unskilled labour. Skilled labour is normally scarce and therefore it is not reasonable to shadow price it at or near zero. It may even be necessary to shadow price it above the prevalent wage to reflect its true scarcity.

18. Capital:

There is a general feeling that capital should be shadow priced because, in underdeveloped countries, its price (rate of interest) does not reflect its true scarcity.

Frequently, instead of the actual borrowing rate, the opportunity cost of capital is used as a measure of its value and proposed projects are compared to the opportunity cost of capital.

B. Measurement of costs and Benefits

We can now proceed to find out how costs and benefits are to be measured. Before discussing various methods, it would be useful to see the distinction between two major aspects of project analysis - the financial and the economic.

The financial aspect deals primarily with the revenue earning consideration of a project. In financial analysis, we are concerned with whether a project can be financially viable. In this analysis, we always use market prices, never accounting prices.

In economic analysis, we attempt to determine whether a given project is likely to contribute to the development of the economy as a whole. Our attention is focussed on finding out if the contribution of the project justifies the use of the required scarce resources.

The basic aim of all cost-benefits analysis is to assess whether a certain project is worth undertaking in the sense that benefits exceed costs. We must however caution ourselves against a danger. We should not consider only the benefit-cost ratio as a static entity but should also consider whether extra benefits exceed extra costs. For example, between A amd B we ,ay find that A has a higher benefit cost ratio. Yet we may prefer B because its extra benefits clearly exceed its extra costs.

We shall first take up undiscounted measure of project worth:

1. Undiscounted measure of project worth:

Let us take four hypothetical pump irrigation investments to illustrate some of the problems associated with using undiscounted measure to choose among projects. All may be thought of as being more or less alternatives for each other.

Four Hypothetical Pump Irrigation Schemes
(in 1000 rupees)

| Project | Year | Project costs | | | Gross costs | Gross value of production | Net value of production(NVP) |
|---|---|---|---|---|---|---|---|
| | | Capital items | O & M costs | Prod. costs | | | |
| I | 1 | 20 | 2 | 3 | 25 | 15 | 10 |
| | 2 | - | 2 | 3 | 5 | 15 | 10 |
| | 3 | - | - | - | - | - | - |
| | Total | 20 | 4 | 6 | 30 | 30 | 20 |
| II | 1 | 20 | 2 | 3 | 25 | 15 | 10 |
| | 2 | - | 2 | 3 | 5 | 15 | 10 |
| | 3 | - | 2 | 3 | 5 | 5.972 | 0.972 |
| | Total | 20 | 6 | 9 | 35 | 35.972 | 20.972 |
| III | 1 | 20 | 2 | 3 | 25 | 10 | 5 |
| | 2 | - | 2 | 3 | 5 | 11 | 6.5 |
| | 3 | - | 2 | 3 | 5 | 17.5 | 12 |
| | Total | 20 | 6 | 9 | 30 | 38.5 | 23.5 |
| IV | 1 | 20 | 2 | 3 | 25 | 10 | 5 |
| | 2 | - | 2 | 3 | 5 | 17 | 12 |
| | 3 | - | 2 | 3 | 5 | 11.5 | 6.5 |
| | Total | 20 | 6 | 9 | 35 | 38.5 | 23.5 |

Ranking by inspection: Project II is better than I because with same investment they produce same NVP in two years, but one continues to produce for three year. IV is better than III because it has more of flow earlier in the same time sequence. But is project IV better than project II?

Payback period: It is one of the common rough means of choosing specially if there is high degree of risk. We can rank the four projects as below:

Payback period

| Project | Payback period (years) | Ranking |
|---|---|---|
| I | 2.0 | 1 |
| II | 2.0 | 1 |
| III | 2.8 | 4 |
| IV | 2.7 | 3 |

Note: Pay back means, return of the capital items, in these cases Rs.20,000

Here projects I and II are equal but by inspection we know II is better than I.

This method has two weaknesses:

1. It fails to consider earnings of the payback period;
2. It fails to take into consideration differences in the timing of proceeds.

Proceeds per rupee of outlay: Sometimes, investments can be ranked by the total proceeds divided by the total amount of investment.

Total proceeds per rupee of outlay

| Project | Project cost Capital items | Net value of production | Proceeds per rupee of outlay | Ranking |
|---|---|---|---|---|
| I | 20,000 | 20,000 | 1.00 | 4 |
| II | 20,000 | 20,972 | 1.05 | 3 |
| III | 20,000 | 23,500 | 1.18 | 1 |
| IV | 20,000 | 23,500 | 1.18 | 1 |

By this criterion, projects III and IV receive equal ranking, even though we know by simple inspection that IV is better than III. This method also fails to consider timing.

Average annual proceeds per rupee of outlay

| Project | Capital items | Total NVP | Average NVP | Average annual proceeds per rupee of outlat | Ranking |
|---|---|---|---|---|---|
| I | 20,000 | 20,000 | 10,000 | 0.50 | 1 |
| II | 20,000 | 20,972 | 6,991 | 0.35 | 4 |
| III | 20,000 | 23,500 | 7,833 | 0.39 | 2 |
| IV | 20,000 | 23,500 | 7,833 | 0.39 | 2 |

It also fails to take length of time into account as it is biased towards short-lived investments with high cash proceeds. Project I is better than project II although by inspection we know project II is better than project I.

Average income on book value of the investment:

In this measure of investment worth, the ratio of annual benefits to the book value of assets (after subtracting depreciation) is the criterion.

Average income on book value

| Project | Average net value of production | Average depreciation | Average income (proceeds less depreciation) | Average book value (of the depreciation) | Income of book value | Rank |
|---|---|---|---|---|---|---|
| I | 10,000 | 10,000 | 0 | 10,000 | 0 | 4 |
| II | 6,991 | 6,667 | 324 | 10,000 | 3 | 3 |
| III | 7,833 | 6,667 | 1166 | 10,000 | 12 | 1 |
| IV | 7,833 | 6,667 | 1166 | 10,000 | 12 | 1 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Timing of profit not accounted adequately.
Col.6 is % of Col.4 over Col.5.

2. <u>Time value of money</u>: Every project yields a stream of benefits. The benefits are not yielded just at one particular time but are likely to be spread over a number of years in the future. We must find a way of taking this important item into consideration. This problem can be illustrated by a simple example. When we lend money, we expect an interest for lending. Why do we expect interest? First, we are depriving ourselves of the use of that money for consumption purposes for a given period and therefore expect a reward. Secondly, we are deprived of the opportunity of using that money for some productive purpose. In other words, we are foregoing an opportunity of earning an income in the present. We expect to be compensated for this by an interest on the money we lend.

Suppose that we lend Rs.650/- to someone who promises to return this after 5 years at an interest rate of 9 per cent. At the end of 5 years we expect to receive Rs.1,000/-. The question is how much that promise is worth to us today. In other words, what is the present worth of Rs.1000/- five years in the future assuming an interest rate of 9 per cent? This is easy to estimate. It can be understood clearly if we first remember how we calculate how much money is due to us at a certain interest after a certain period. If we lend Rs.650/- in 1975 at an interest of 9 per cent, we expect to receive in 1980 Rs.1000/-. We multiply the amount due each year by 1.09. If we reverse this procedure, we get the present worth. This is shown in the following table.

| Year | Amount promised at the end of the year | Interest rate | Worth at the beginning of the year |
|---|---|---|---|
| 1980 | 1000 | 1.09 | 917 |
| 1979 | 917 | 1.09 | 841 |
| 1978 | 841 | 1.09 | 772 |
| 1977 | 772 | 1.09 | 708 |
| 1976 | 708 | 1.09 | 650 |
| 1975 | 650 | | |

We can see from this table that the present worth of a future income of Rs.1000/- five years hence is Rs.650/-. This procedure is known as discounting. The interest rate assumed for discounting is the discount rate. There is no difference between the interest rate and the discount rate. Only the interest rate looks from now to the future whereas the discount rate looks backward from the future to the present.

It is time consuming to keep on calculating in the way we have done in the table above. It is simpler and quicker to consult Compounding and Discounting tables. These tables give the discount factors (also known as the present worth factors) for various rates for different periods. For example, for a discount rate of 10 per cent, the discount factor for 1 year is 0.009. Such a table is appended to Gittinger's book cited below.*

3. Stream of income:

Often we may expect to receive a stream of income spread over a number of future years rather than a single amount at the end of a particular period. This kind of question is specially important in project analysis since

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* J. Price Gittinger: Economic Analysis of Agricultural Projects, Johns Hopkins University Press, 1972.

many projects yield the same benefits every year for a number of years. It is essential to know the present worth of a future stream of benefits. Only then can we estimate how much we would be justified in investing today to receive that stream. This is illustrated in the table below:

| Year | Income to be received | Discount factor at 15 per cent | | Present worth |
|---|---|---|---|---|
| 1975 | 6438 | .870 | = | 5,001 |
| 1976 | 6438 | .756 | = | 4,867 |
| 1977 | 6438 | .658 | = | 4,236 |
| 1978 | 6438 | .572 | = | 3,683 |
| 1979 | 6438 | .497 | = | 3,200 |
| 1980 | 6438 | .432 | = | 2,781 |
| 1981 | 6438 | .376 | = | 2,421 |
| 1982 | 6438 | .327 | = | 2,105 |
| 1983 | 6438 | .284 | = | 1,828 |
| Total | 57942 | 4.772 | | 30722 |

We see that the present worth of a stream of income of Rs.6,438/- received each year for nine years at a discount rate of 15 per cent is Rs.30,722/-. The undiscounted value of the income stream is Rs.57,942/- but this is not the present worth. What this means is that Rs.6,438/- received in 1983 is not worth Rs.6,438/- today. This is, of course, the whole purpose of discounting.

The calculations made in the table above can be simplified if we simply take the sum of the discount factors (present worth factors) and multiply it by the annual income to be received. Hence, Rs. 6,438 x 4.722 = Rs. 30,722/-.

What does this mean for project appraisal? It implies that if the current rate of interest is 15 per cent, then it is worth our while investing Rs.30,722/- in a project which would yield an annual return of Rs. 6,438/- for nine years.

Let us now turn to an interesting problem. There are several projects which do not yield benefits from the first year. Take the example of a project which begins to yield benefits only from the fifth year. Then we would be concerned only with the present worth of a future income stream which begins from the fifth year and continues up to the life span of the project, say, twenty-five years. We shall illustrate this with the example given above but assuming that the income stream starts from the fifth year and continues up to the ninth year.

| Year | Income to be received | | Discount Factor (15%) | | Present worth |
|---|---|---|---|---|---|
| 1979 | 6438 | x | .497 | = | 3,200 |
| 1980 | 6438 | x | .432 | = | 2,781 |
| 1981 | 6438 | x | .376 | = | 2,421 |
| 1982 | 6438 | x | .327 | = | 2,105 |
| 1983 | 6438 | x | .284 | = | 1,828 |
| Total | 32,190 | x | 1.916 | = | 12,335 |

There is a short-cut for getting to this result. This is shown below.

| | | |
|---|---|---|
| Present worth of an annuity factor for 9 years at 15% | = | 4.772 |
| Minus, Present worth of an annuity factor for 4 years at 15 per cent | = | - 2.856 |
| Present worth of an annuity factor from years 5 to 9 at 15 per cent. | = | 1.916 |

Armed with this fundamental notion of discounting, we shall proceed to see how it is applied. The simplest measure is the benefit-cost ratio which is computed as follows:

$$\frac{\text{Present worth of benefits}}{\text{Present worth of costs}} = \text{Benefit - Cost ratio.}$$

How do we decide what discount rate is to be used? There are three solutions. The best is to use the <u>opportunity cost of capital</u> - the profitability of the last possible investment in the economy given the total available capital. The difficulty here is to estimate the opportunity cost. It is commonly observed that in underdeveloped countries the opportunity cost of capital is between 8 and 15 per cent.

Alternatively one would use the borrowing rate for the project to be financed. The difficulty here is that the benefits of a project will be unduly influenced by the financing terms available rather than by the contribution made by the project to the economy.

The third discount rate is the social rate of return. This is the benefit which reflects what is called the time preference of society as a whole. The rate of time preference indicates the preference for present consumption over future consumption. This again is difficult to calculate.

The calculation of the benefit-cost ratio is given below:

$$BCR = \frac{\sum_{t=1}^{n} \frac{Bn}{(1+i)^n}}{\sum_{t=1}^{n} \frac{Cn}{(1+i)^n}}$$

where BCR = Benefit-cost ratio
Bn = cost in each year
i = interest
n = number of years

| Project | Year | Capital items | O & M cost | Pro. cost | Gross cost | D.F 12% | Present worth 12% | TV of proj. G.B. | D.F. 12% | Present worth 12% |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 1 | 20000 | 2000 | 3000 | 25000 | 0.893 | 22,325 | 15000 | 0.893 | 13395 |
| | 2 | - | 2000 | 3000 | 50000 | 0.797 | 3,985 | 15000 | 0.797 | 12955 |
| | 3 | - | - | - | - | - | - | - | 1.690 | - |
| | Total | | | | | | Rs.26310 | | | Rs.26350 |

I Benefit-Cost ratio at 12% $= \frac{25350}{26310} = 0.96$ Net present worth $26350 - 26310 = 40$

II - do - $\frac{29602}{29870} = 0.99$

III - do - $\frac{30200}{29000} = 1.01$

IV - do - $\frac{30667}{29870} = 1.03$

D.F. = Discount Factor
T.V. = Total Value
G.B. = Gross Benefit.

## 4. Concept of multiplier:

The marginal propensity to consume helps us to express in a systematic manner the relationship between a given increment in investment and the resulting change in income. Suppose on a given day an investment of Rs. 100/- takes place. Now, the first impact of this change will be that income of persons engaged in investment activity will go up by 100. The process, however, does not end here. The recipients of income will spend a

part of the additional income and save the rest - the magnitude of the additional spending will depend on the marginal propensity to consume(mpc).

Suppose mpc is 3/4. They will spend Rs.75 and save Rs.25. When they spend Rs.75 in buying goods and services, the income of the sellers of these goods and services go up by Rs.75. They will in turn spend a part of it, depending on their marginal propensity to consume. If their mpc is also 3/4, they will spend Rs.56.25 and save the rest. Thus one primary round of expenditure creates income much higher than original amount. If the marginal propensity to consume is stable, the series of successive expenditures grows in a geometric progression.as shown below.

$$100 + 100 \times 3/4 + 100(3/4)^2 + 100(3/4)^3 + 100(3/4)^4$$

$$\begin{aligned} \Delta Y &= 100 \left\{1 + (3/4) + (3/4)^2 + (3/4)^3 + (3/4)^4 + \ldots\right\} \\ &= 100 \left( \frac{1}{1-3/4} \right) \\ &= 100 \times 4 \\ &= \text{Rs. } 400 \end{aligned}$$

Thus we see that an initial primary investment of Rs.100/- gives rise to an increase of Rs.400/- in the national income. The investment measures the relationship between an increase in income caused by a primary increase in investment.

$$\text{Investment multiplier} = \frac{Y}{I} = \frac{400}{100} = 4$$

$$= \frac{1}{1 - \text{mpc}} = \frac{1}{\text{mps}}$$

If mpc is 4/5, multiplier will be 5; and if mpc is 9/10 it will be 10.

mps = marginal propensity to save.

5. <u>Discounted cash flow</u>:

In this method we estimate the worth of a project by subtracting the costs from the benefits on a year-to-year basis and thus arrive at the incremental net benefit stream (known as the "cash flow") and then discounting that.

6. <u>Derivation of the cash flow</u>:

Every project earns a stream of gross benefits. From this we must deduct the capital investment and the costs of other inputs. We are then left with a residual. This residual is available for two purposes:

a) to recover the investment made in the project; this is the return of capital.

b) to compensate for the use of capital used in the project - this is the return to or on capital.

This residual is the cash flow. The cash flow includes both the returns <u>to</u> and <u>of</u> capital. In effect the whole thing can be represented as follows.

Gross return less capital items and inputs less labour and management costs = cash flow.

The above is a derivation of cash flow in economic analysis in which some prices may be shadow prices. In financial analysis all prices are market prices. Also taxes and subsidies are included. Then,

Gross return less capital items, inputs and taxes less labour management costs = cash flow.

Two points should be noted. In the early years of the project the investment costs and initial operating and

maintenance costs may well exceed benefits. Therefore, we may have a negative cash flow. Secondly, the cash flow may contain some non-cash elements.

7. <u>Net present worth</u>:

This is referred to as NPW. It is the present worth of the cash flow stream. It can be computed by finding the difference between the present worth of the benefit stream <u>less</u> the present worth of the cost stream. Even here we would be confronted with the problem of choosing the right discount rate. Most authors recommend use of the opportunity cost of capital.

8. <u>Internal rate of return</u>:

In this method we attempt to find that discount rate which just makes the NPW of the cash flow equal zero. Such a discount rate is known as the internal rate of return. It represents the average earning power of the money used in the project over the life of the project. The internal rate of return drives the NPW of the project to zero. At that discount rate the project breaks even. In other words it will earn back all the capital and operating costs spent on it and also pay the project-sponsors 18 per cent for the use of their money in the meantime. Such a rate of return will make the benefit-cost ratio equal to one.

The problem is that there is no readily applicable formula for finding a discount rate which will make the cash flow equal to zero. It can only be found by trial and error. There is however a method of estimating the internal rate of return which will help us avoid making too many errors. This is shown in the following table; but before that let us take the example of a project where the internal rate of return makes the cash flow equal zero.

| Year | Capital items | Operation and maintenance costs | Production costs | Gross costs | D.F. 18% | Present worth | Total value of production (Gross benefits) | Present worth | Incr. Ben. (Cash flow) | Present worth 18% |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7500 | 0 | 0 | 7500 | 847 | 6352 | 0 | 0 | -7500 | -6352 |
| 2 | 6000 | 0 | 0 | 6000 | 718 | 4308 | 0 | 0 | -6000 | -4308 |
| 3 | 0 | 600 | 700 | 1300 | 609 | 792 | 6000 | 3654 | +4700 | +2862 |
| 4 | 0 | 600 | 700 | 1300 | 516 | 671 | 6000 | 3096 | +4700 | +2425 |
| 5 | 0 | 600 | 700 | 1300 | 437 | 568 | 6000 | 2622 | +4700 | +2054 |
| 6 | 0 | 600 | 700 | 1300 | 370 | 481 | 6000 | 2220 | +4700 | +1739 |
| 7 | 0 | 600 | 700 | 1300 | 314 | 408 | 6000 | 1884 | +4700 | +1476 |
| 8 | - | - | - | - | 314 | - | 331 | 104 | + 331 | + 104 |
| Total | 13500 | 3000 | 3500 | 20000 | 3811 | 13580 | 30331 | 13580 | 10331 | 0 |

Note: The figures 314 and 331 in the last row are omitted. The former is omitted from the total to avoid double counting. The latter represents salwage value (described below).

$$\text{Benefit - cost ratio at } 18\% = \frac{13,580,000}{13,580,000} = 1.0$$

N.P.W. at 18% $\quad$ 13,580,000 - 13,580,000 = 0

Internal rate of return = 18%

The previous table illustrates how a particular rate of discount, in this instance 18 per cent, makes the NPW equal to zero and benefit cost ratio equal to one. You will see that the present worth on both the cost side and the benefit side is derived by multiplying the gross costs and benefits respectively by the discount factor. To get at the discount factor for one year for any rate of discount one should consult discount tables.

It was mentioned earlier that we have no formula for choosing the discount rate. The only way is to begin with a quick guess and choose a rate which commonsense tells us is in the right neighbourhood. There is a method of making a first approximation which I give below. The figures in the table below are taken from the previous table.

<u>Initial estimate of the internal rate of return</u>

Find:

1. $\dfrac{\text{Average annual benefits}}{\text{Total initial costs}} \quad \dfrac{4700}{13500} = .35$

   This .35 = estimated internal rate of return in decimal terms.

2. Next we have to reduce the estimate of step 1 by the approximate amount which is given by the table below (Note that we do not have the derivation of this table which is like an annuity or discount table)

| Duration of the benefit stream year | Estimated value in Step 1 | | | |
|---|---|---|---|---|
| | Less than 0.1 | 0.1-0.2 | 0.2-0.3 | Less than 0.31 |
| 5 | - | - | 0.18 | 0.13 |
| 10 | 0.08 | 0.07 | 0.05 | 0.02 |
| 15 | 0.05 | 0.03 | 0.02 | 0.0 |
| 20 | 0.02 | 0.01 | 0.0 | 0.0 |
| 25 | 0.02 | 0.01 | 0.0 | 0.0 |
| More than 25 | 0.0 | 0.0 | 0.0 | 0.0 |

Taking the benefit stream as years we get .35 - 0.13 = .22

3. Next we reduce the estimate of step 2 according to the following table:

| Investment Period | Subtract from Step 2 estimate |
|---|---|
| 1 | 0 |
| 2 | ½ (Step 2 estimate)$^2$ |
| 3 | (Step 2 estimate)$^2$ |
| 4 | 1.5 (Step 2 estimate)$^2$ |
| 5 | 2 (Step estimate)$^2$ |

Taking this period as 2 years we get

$$\frac{.22 \text{ x } .22}{2} = .02\text{, hence } .22 - .02 = .20$$

4. If there is a lapse between end of investment period and beginning of benefit period adjustments have to be made as follows:

| Lapse (Year) | Subtraction Step 3 estimate |
|---|---|
| 1 | (Step 3 estimate)$^2$ |
| 2 | 2 (Step 3 estimate)$^2$ |
| 3 | 3 (Step 3 estimate)$^2$ |
| 4 | 4 (Step estimate)$^2$ |
| 5 | 5 (Step 3 estimate)$^2$ |

In ample there is no lapse and hence no need for adjustment.

5. If benefits are larger in early years than in later year, we increase the step 4 estimate somewhat. If benefits are greater in later years than in early years, we decrease the step and estimate somewhat.

6. Obtain the estimated internal rate of return in percentage terms (Step 5 estimate - in this case steps 4 and 5 do not apply -multiplied by 100)

So, .20 x 100 = 20 per cent.

The next step is to discount the cash flow by 20 per cent. The cash flow figures are found in column 10 of the previous table. If this is discounted by 20 per cent it will be found that the present worth is Rs.560/-. This indicates that the present worth of the costs is greater than the present worth of the benefits. The project cannot pray such a high rate of interest and still recover the capital investment. Hence the discount rate is too high.

On the other hand, if we choose 15 per cent and discount the cash flow, we get a value of Rs.977/. This positive flow indicates that the present worth of the benefits is greater than the present worth of the costs. This implies that the project could play a higher rate of interest and still recover the capital investee. Hence 15 per cent is too low.

Instead of using a trial and error method to find the correct rate we would do it by interpolation. This is done as follows:

Internal rate of return =

$$\text{Lower discount rate plus difference between the two discount rates} \times \frac{\text{Present worth of cash flow at the lower rate}}{\text{Absolute difference between the present worth of the cash flow at the two discount rates.}}$$

Reverting to the example used above we therefore get:

$$\underset{\text{(lower rate)}}{15} + \underset{\text{(difference between the two rates)}}{5} \times \frac{977 \text{ (PW at lower rate)}}{1537 \text{ (absolute difference)}}$$

$$= 15 + 5\ (.64) = 15 + 3.2 = 18 \text{ per cent.}$$

Note that absolute difference is merely the sum of the two values ignoring the plus or minus sign attached to them.

Please note that I have not reproduced the entire table to show how the present worth of the cash flow is arrived at after discounting. This is with a view to keeping the essay from getting absurdly long. All that is done is to take the cash flow figures from Table and multiply them by the approximate discount factors for 15 and 20 per cent respectively.

In evaluating projects they are to be ranked in the order of the value of the internal rate of return.

It should also be noted that a project which continues longer with the same investment is always to be preferred. Similarly a project with earlier return is preferred to one with later return.

Another important question is for how long cost benefit analysis should be carried out. Normally we should choose a period of time roughly comparable to be economic life of a project.

At the end of a project the capital asset will not have been used up completely. There will be a residual asset. This is the salvage value and is treated as a benefit from the project in the last year of the analysis. This is how the figure Rs.331 in column 8 of Table.

One final point on this subject I have described the steps for deriving the interval rate of return. The derivation on the table is not presented. It is adopted from J. Price Giltinger's book and is itself taken from another source.

C. Treatment of Uncertainty (Sensitivity analysis)

In the course of construction of a present costs may increase. Can the project's internal return bear this? In other words how sensitive is it to increased costs or fall in prices of lengthening of the implementation period? To see what happens in such changed circumstances the analysis has to be reworked. This is called sensitivity analysis.

There are four main aspects to sensitivity analysis in relation to agriculture -- prices, delays in implementation, cost overrun and yields.

1. Prices:

It is necessary to every agricultural project to find out how its profitability will be affected if the price assumptions prove wrong. For this purpose, we have to make alternative assumptions about future prices and see how these affect the internal rate of return.

2. Delays in implementation:

Most projects are subject to delay. Therefore the impact of delay on a project has to be examined.

3. Cost overrun:

This is specially important in projects where there are significant consumption costs.

4. Yields:

These occupy an important place because there is a tendency to the over-optimistic about future yields, particularly with regard to new cropping patterns, etc. It is therefore necessary to test how sensitive a project's returns are to lower yields.